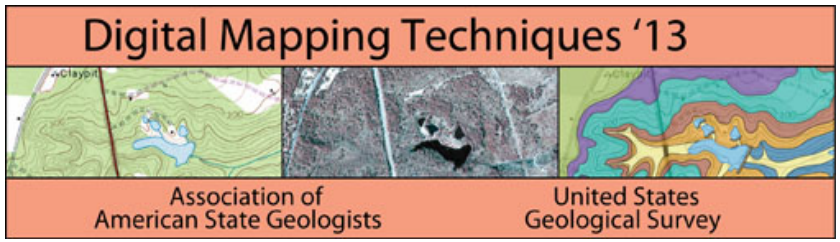


The following was presented at DMT'13
(June 2-5, 2013, Golden, CO).

The contents are provisional and will be
superseded by a paper in the
DMT'13 Proceedings.

See also earlier Proceedings (1997-2012)
http://ngmdb.usgs.gov/info/dmt/

AASG
Association of American State Geologists

USGS
science for a changing world

State-Wide Stereo Model Coverage for Utah

Kent D. Brown
Utah Geological Survey

UTAH DNR GEOLOGICAL SURVEY

June 2-5, 2013
Golden, Colorado

State-Wide Stereo Model Coverage

In 1990, the Utah Geological Survey began using photogrammetry technology to map the geology of Utah.

State-Wide Stereo Model Coverage

What is photogrammetry?

The science of making reliable and precise 3-D measurements by the use of stereo aerial photographs.

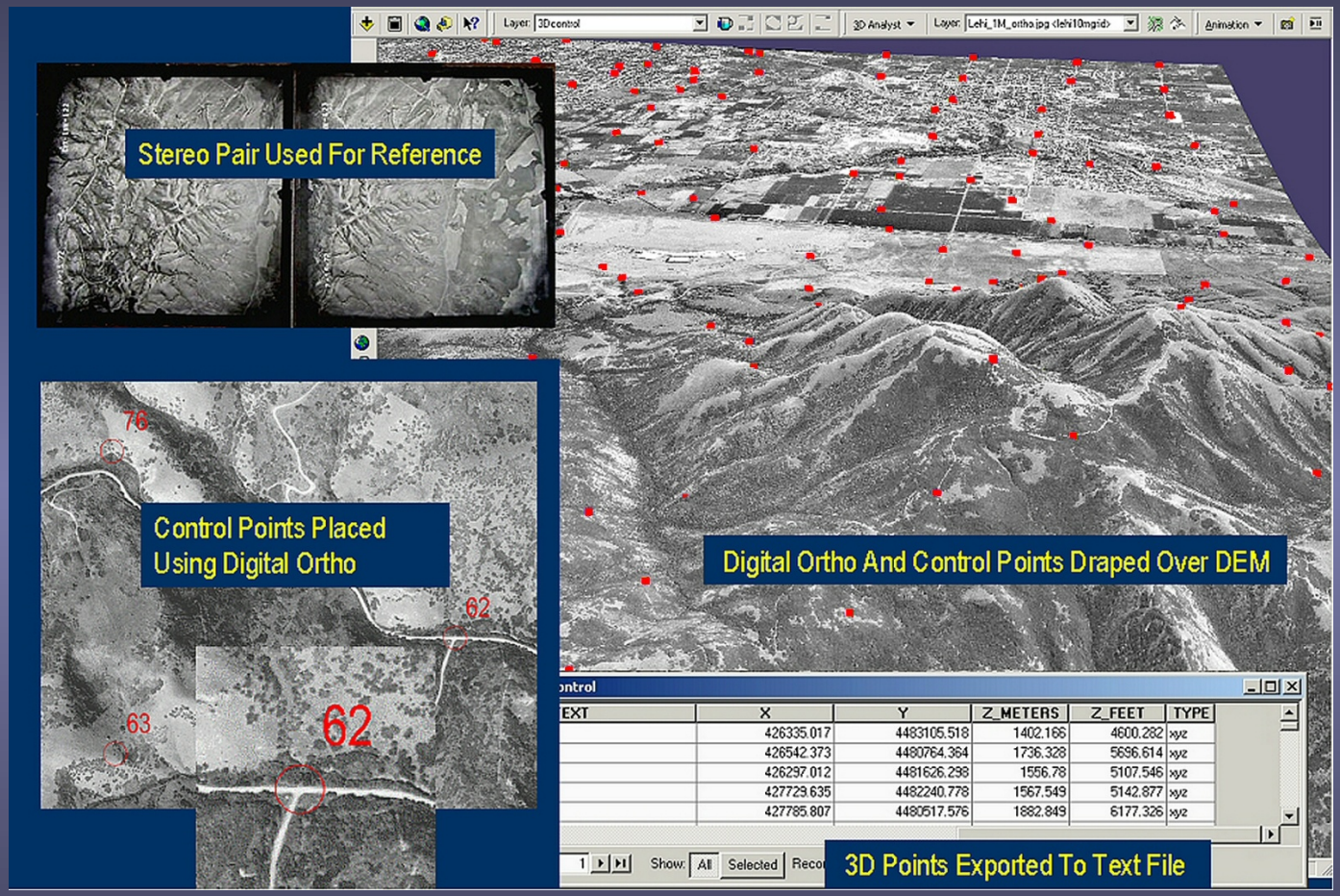
Our First Phase

Analytical Photogrammetry:
Stereoplotter and VrOne Software

Analytical Photogrammetry

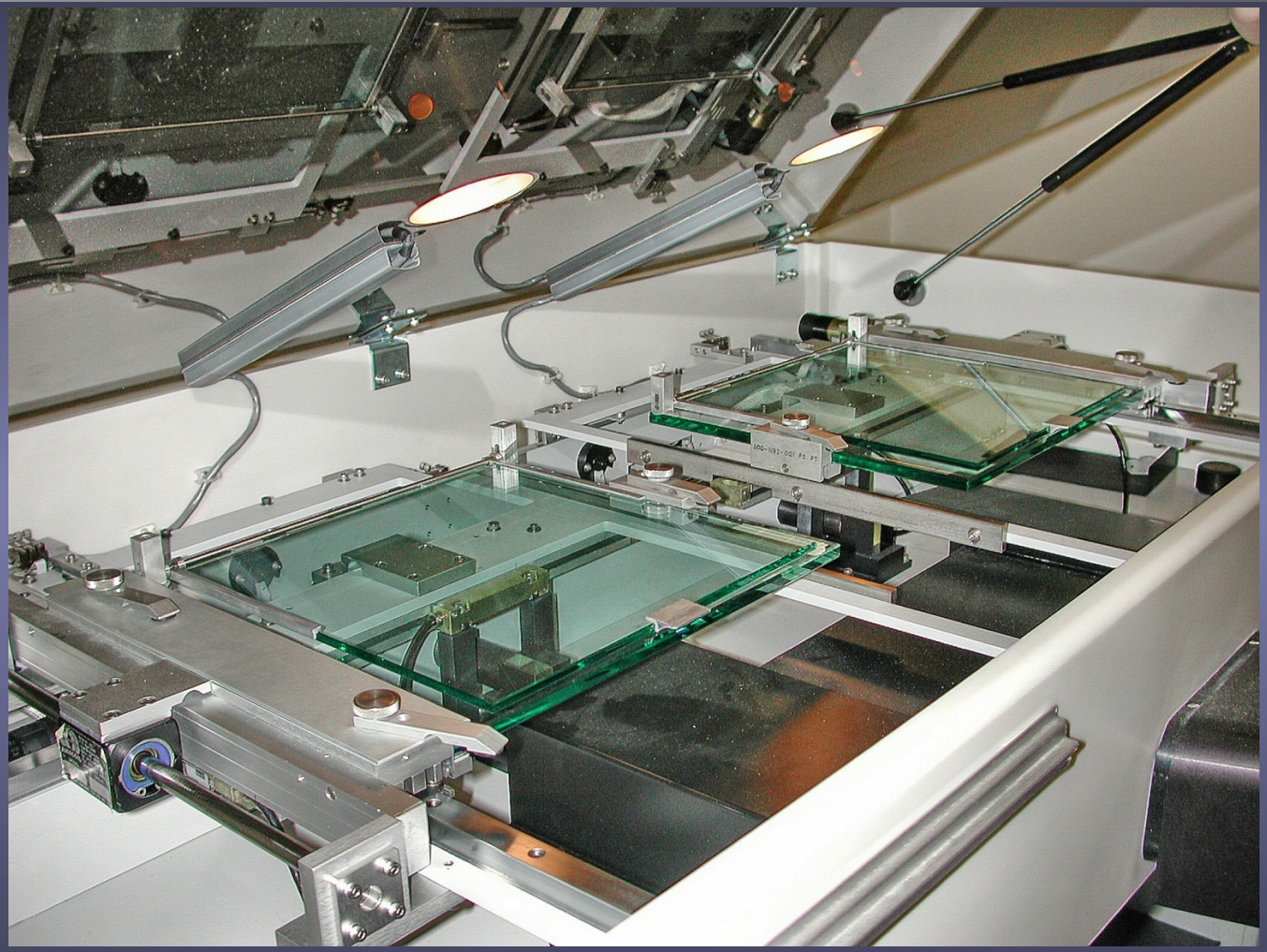
With a special legislative appropriation, the UGS purchased an analytical stereoplotter, the Alpha 2000.

Analytical Photogrammetry

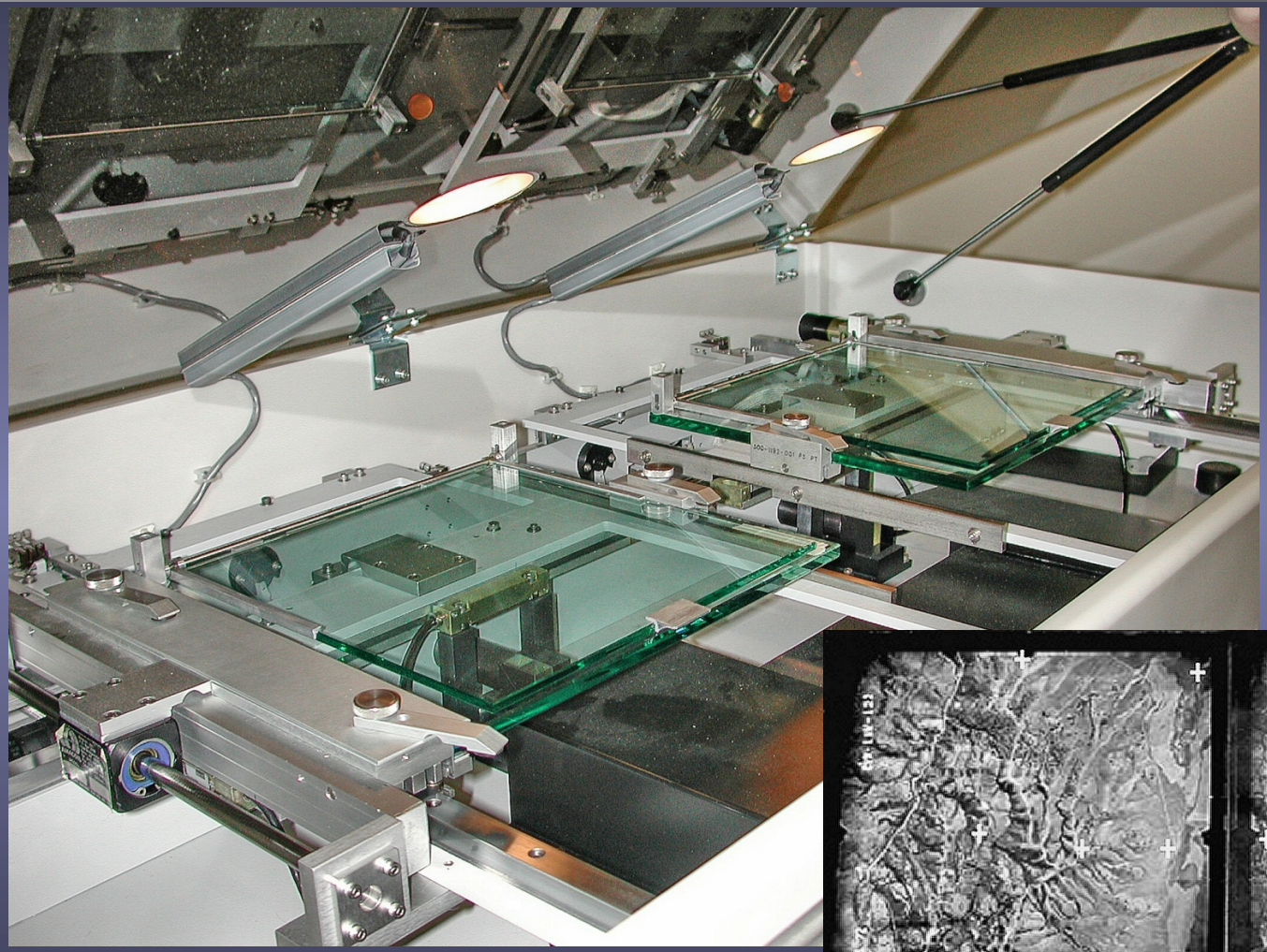


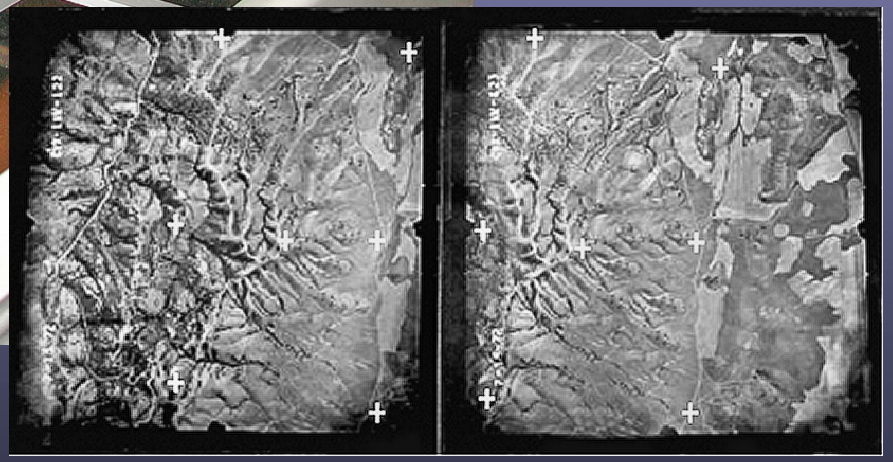
Establish hundreds of ground control points.

Analytical Photogrammetry



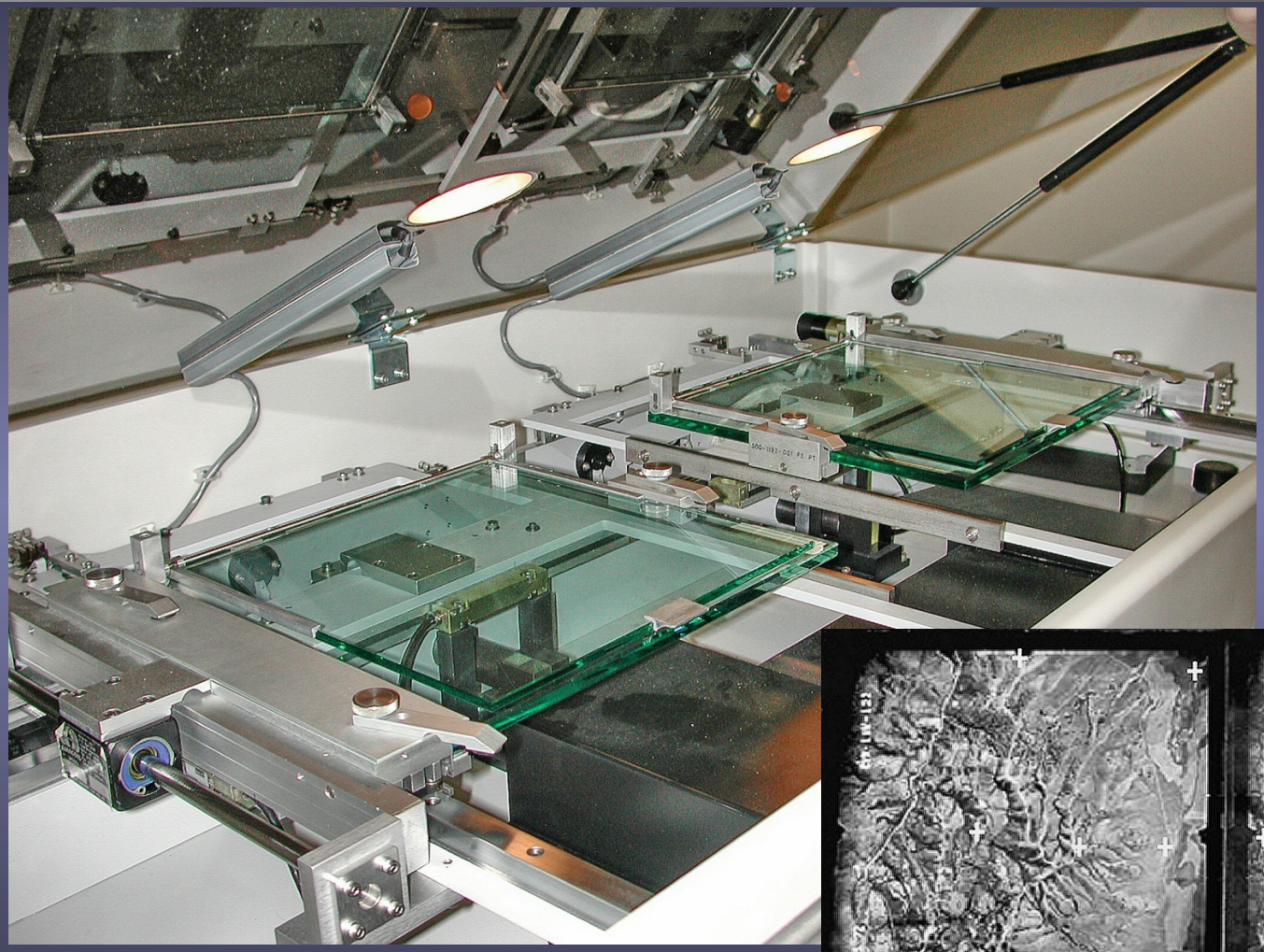
Analytical Photogrammetry



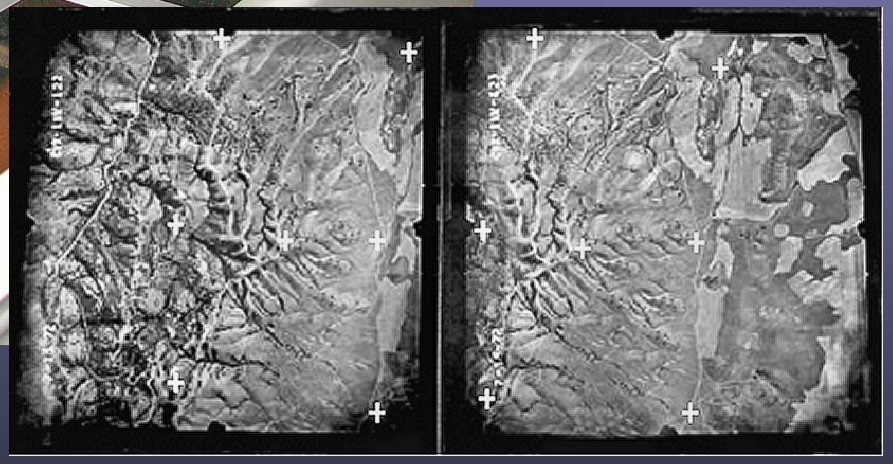


UTAH DNR GEOLOGICAL SURVEY

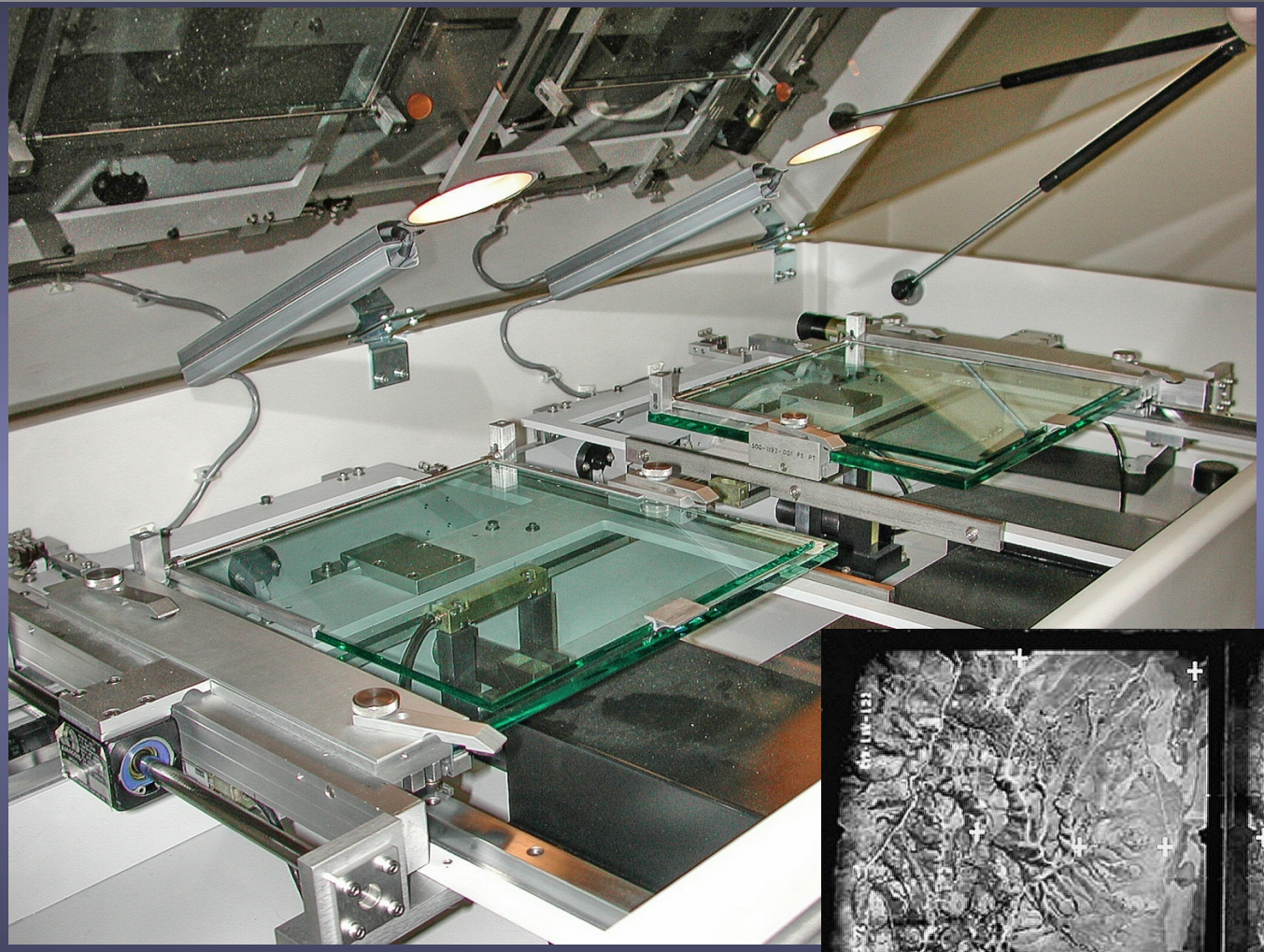
Analytical Photogrammetry



Three orientations:

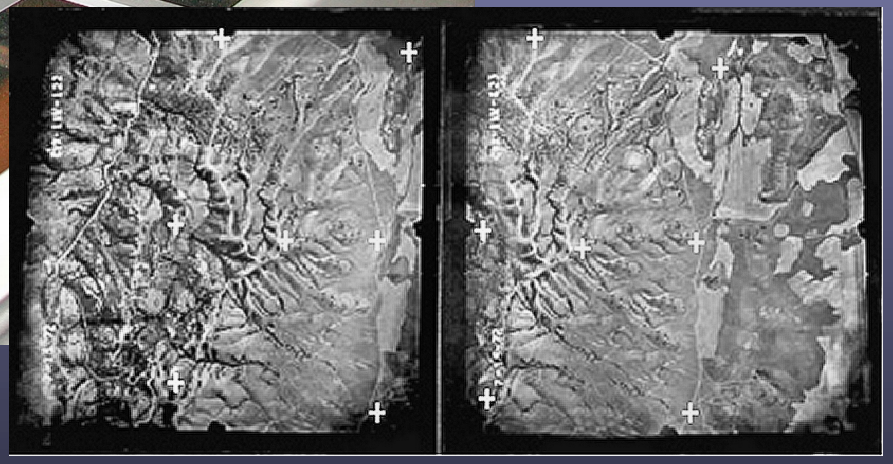


Analytical Photogrammetry



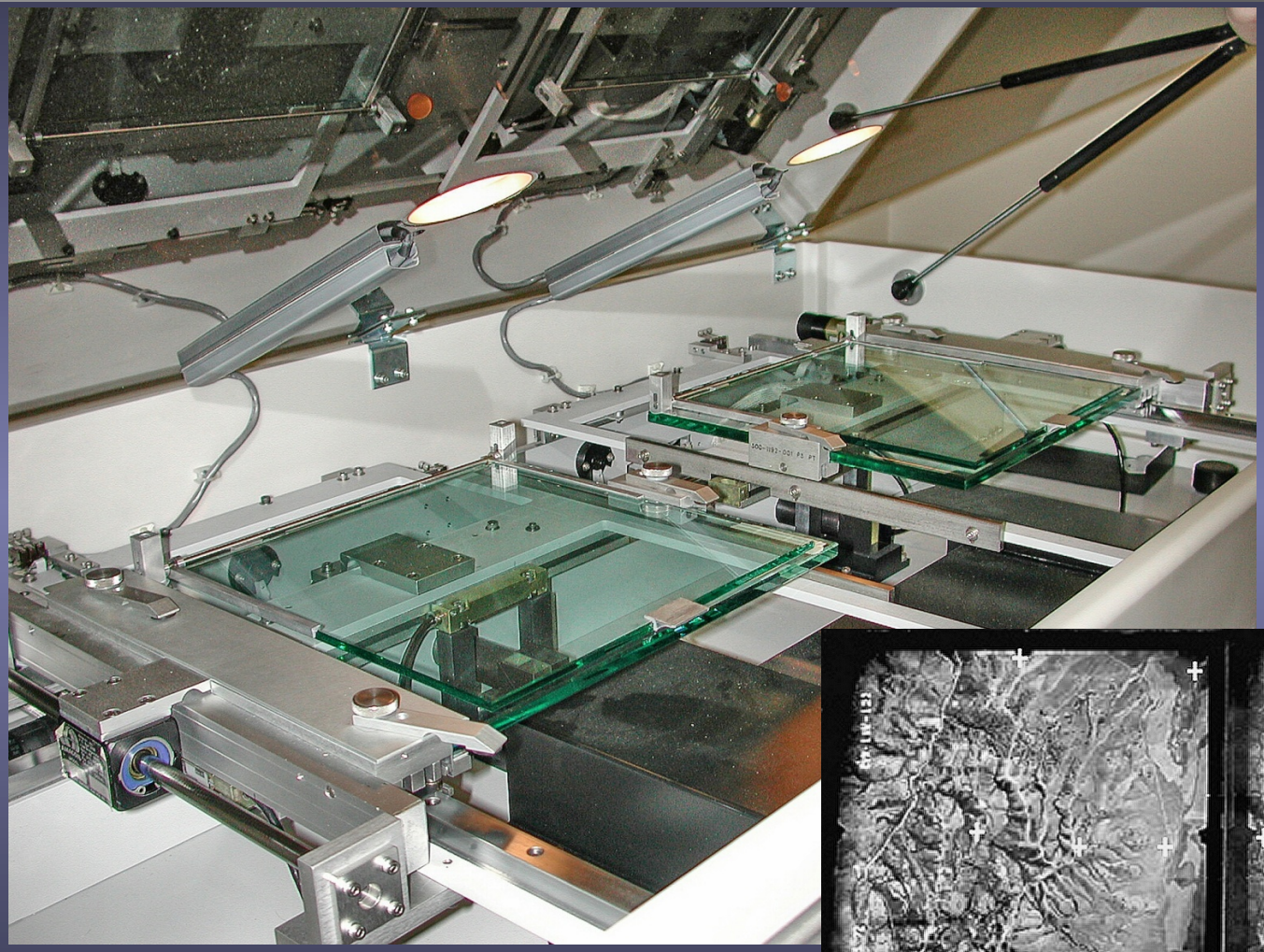
Three orientations:

Inner Orientation



UTAH DNR GEOLOGICAL SURVEY

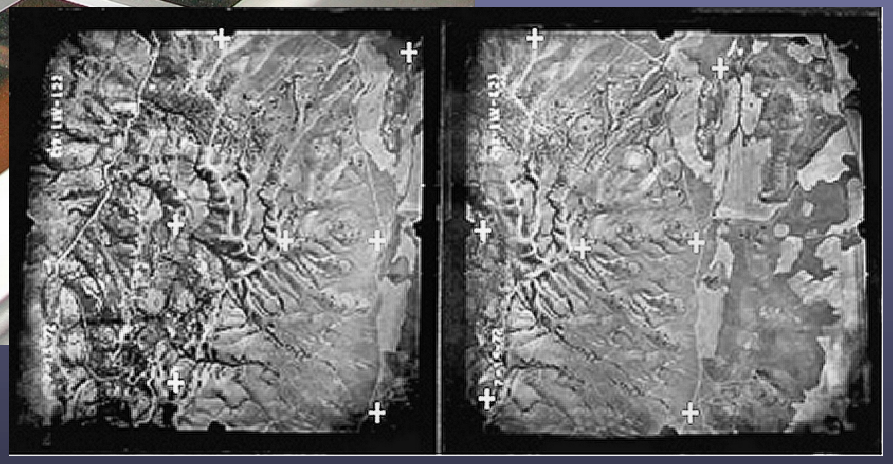
Analytical Photogrammetry



Three orientations:

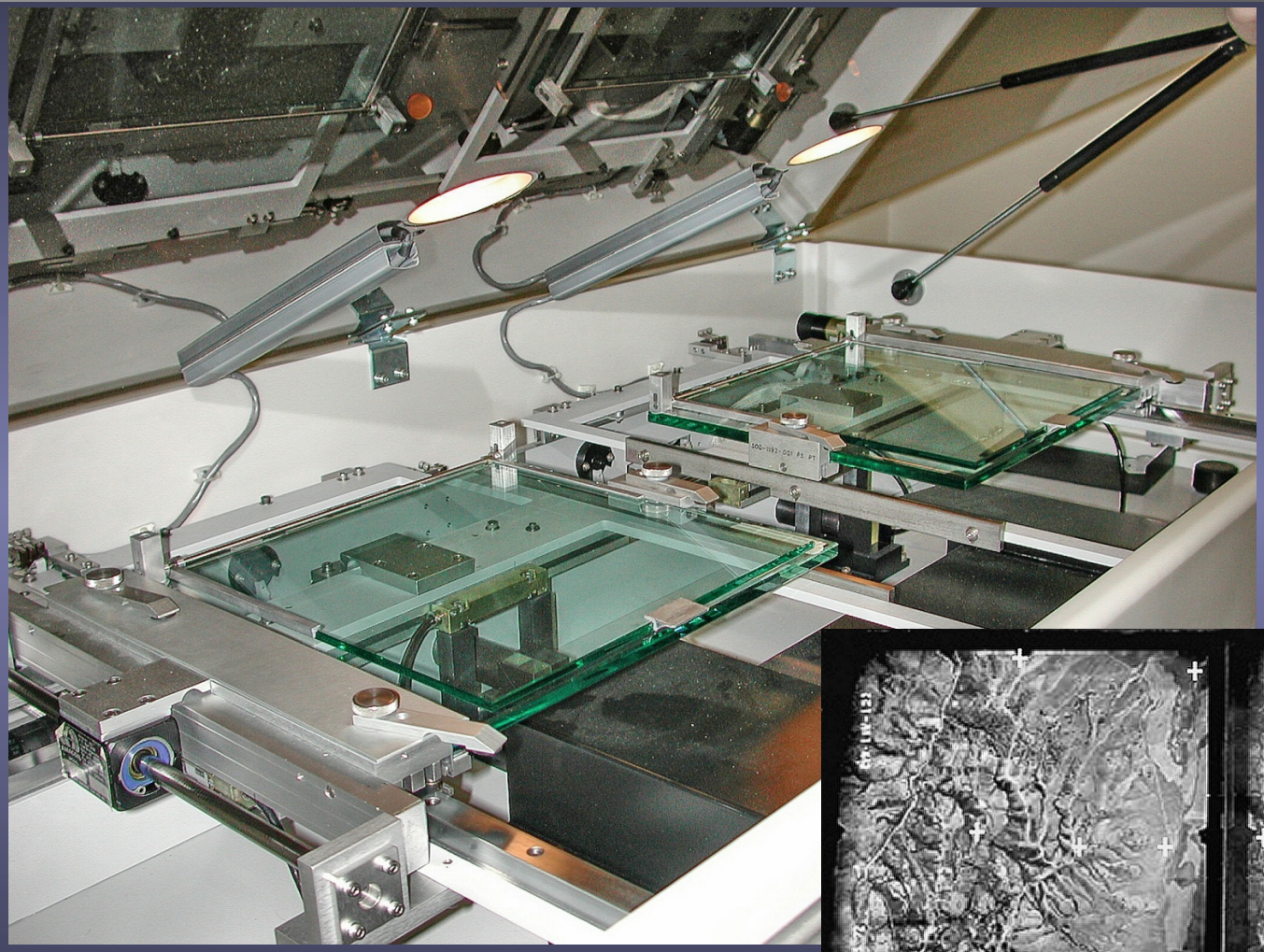
Inner Orientation

Relative Orientation



UTAH DNR GEOLOGICAL SURVEY

Analytical Photogrammetry

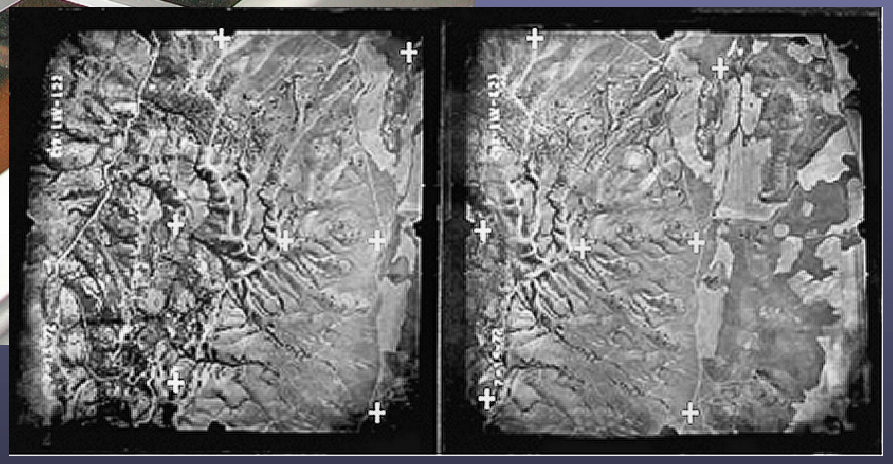


Three orientations:

Inner Orientation

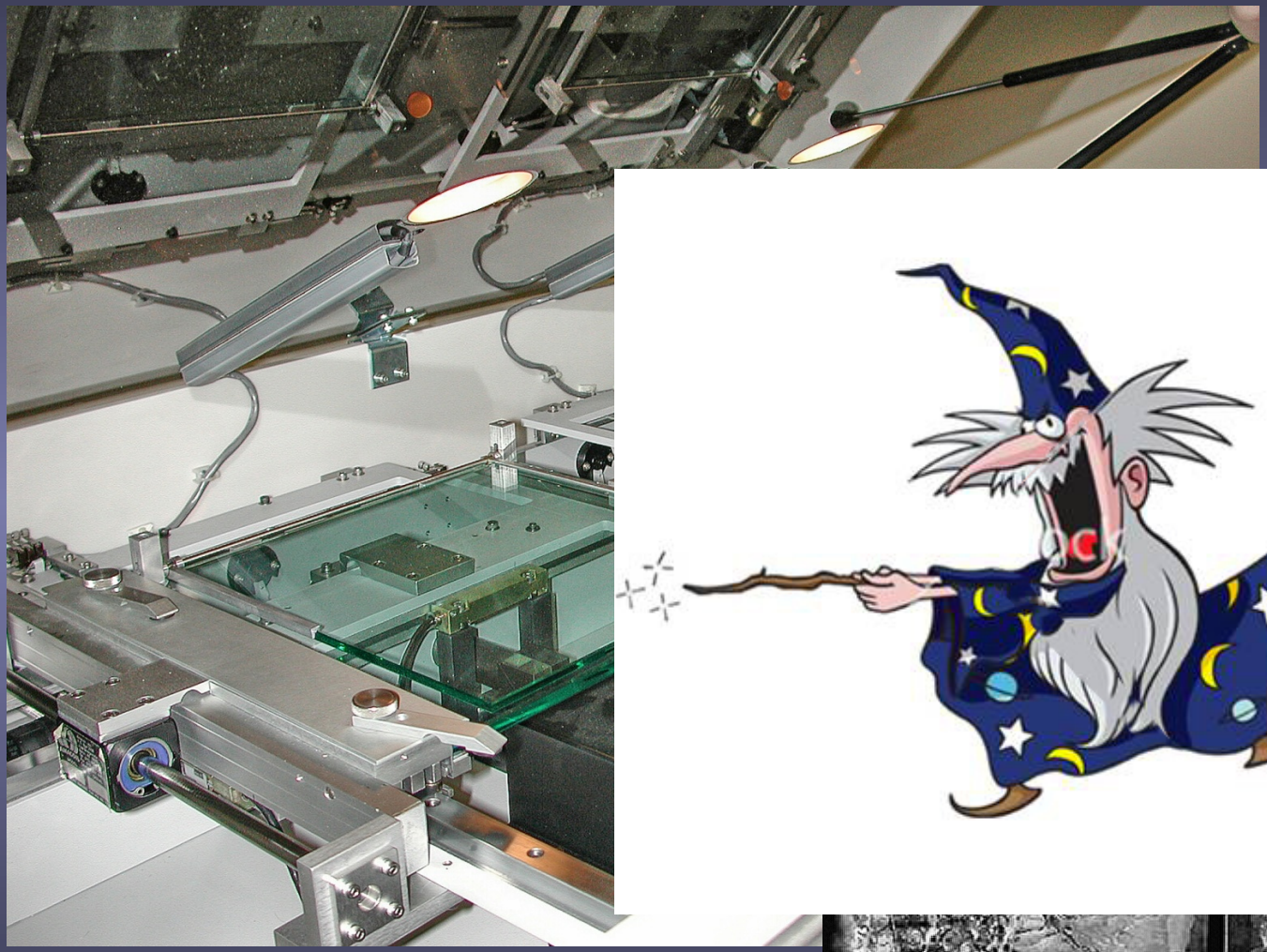
Relative Orientation

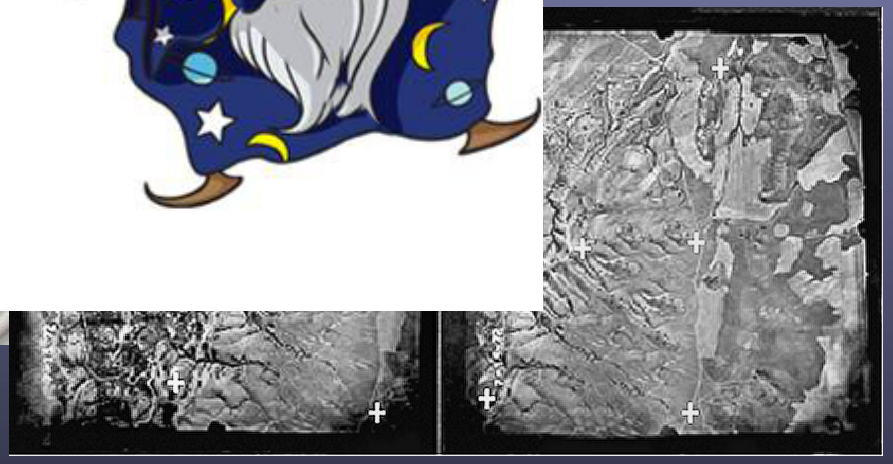
Absolute Orientation



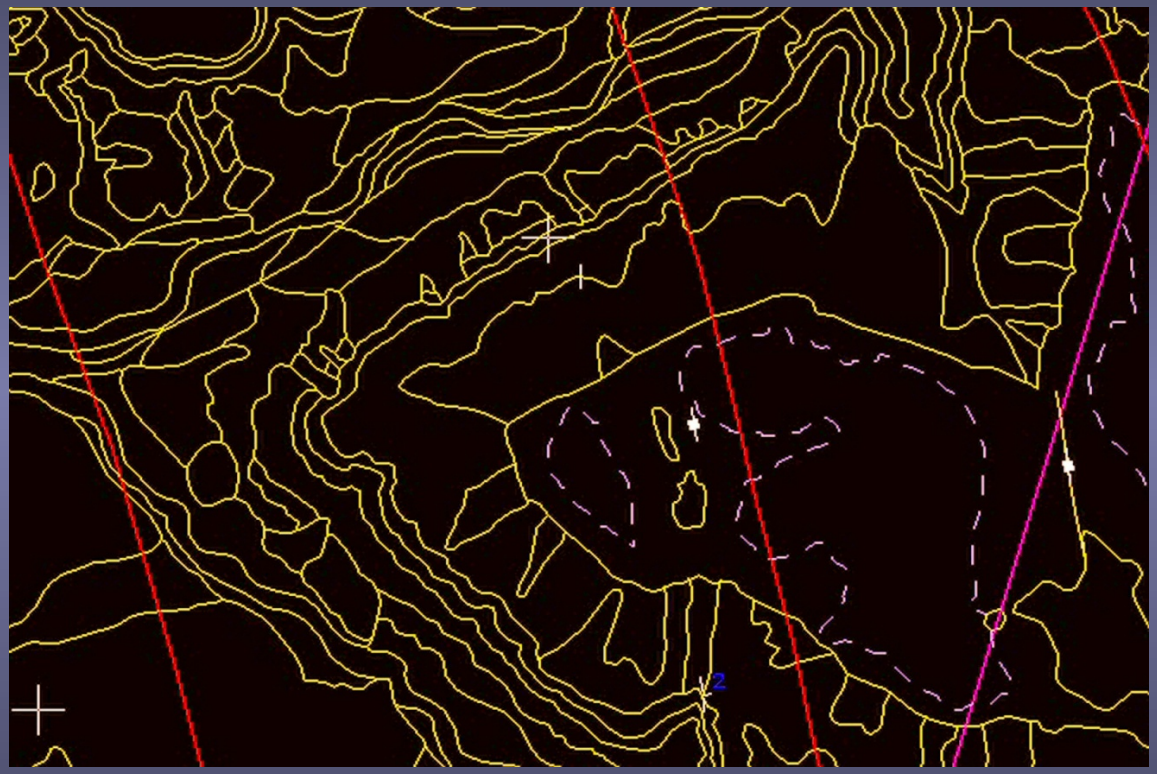
UTAH DNR GEOLOGICAL SURVEY

Analytical Photogrammetry





Analytical Photogrammetry

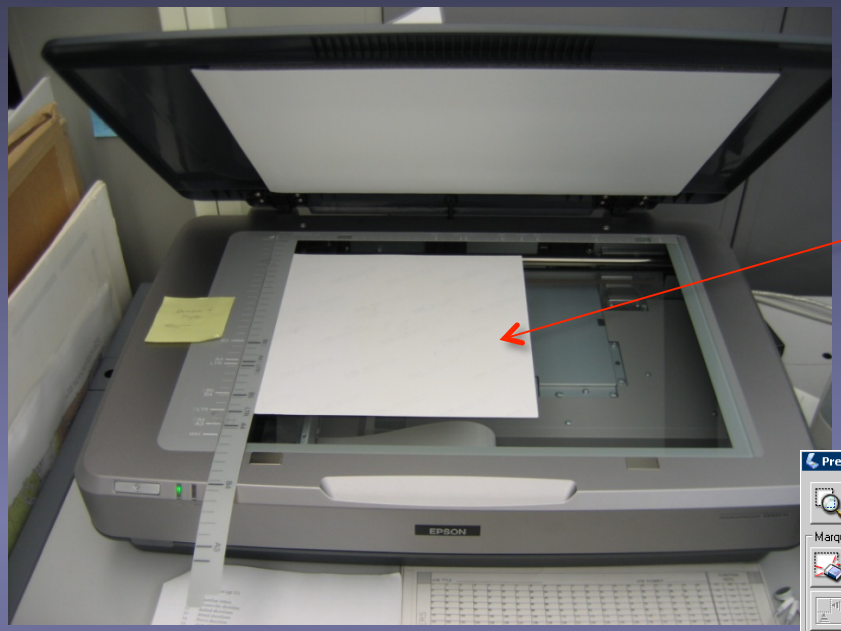


This is what you see on the applications computer screen.

Next Phase

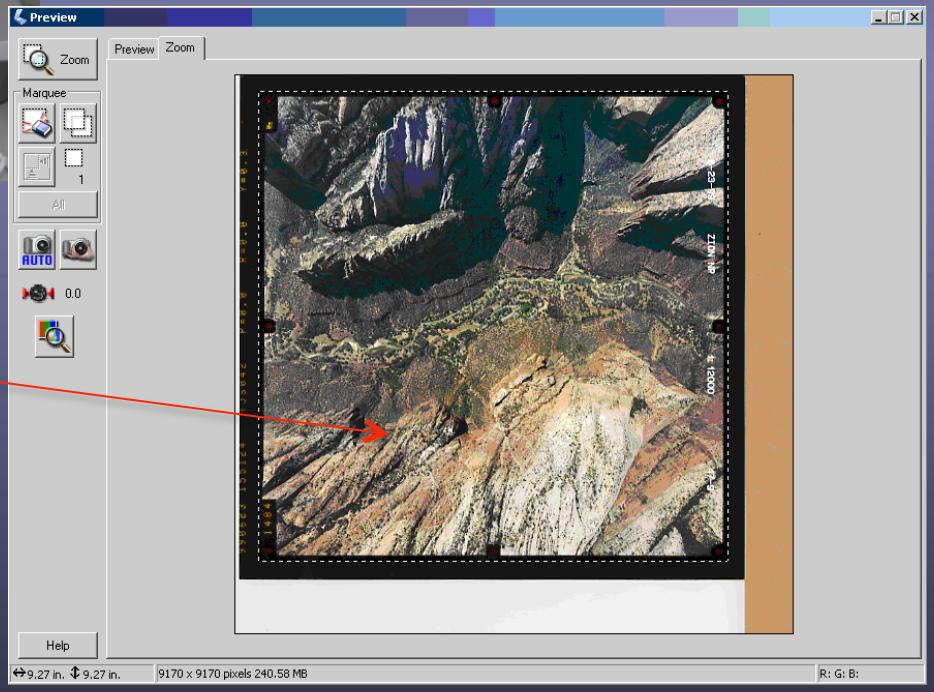
Digital Photogrammetry: VrTwo

Digital Photogrammetry



Scan aerial photos at high-resolution (>1000ppi)

Save images as TIF files



Digital Photogrammetry

- Same ground control as with analytical

Digital Photogrammetry

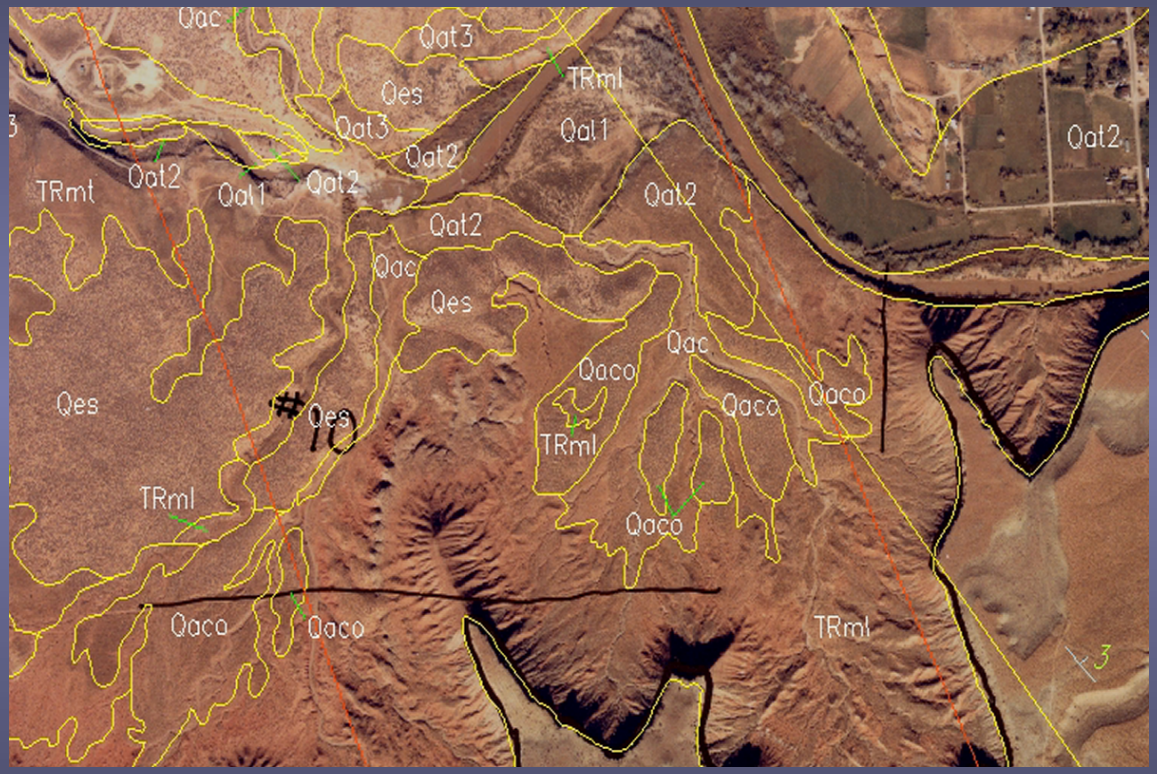
- Same ground control as with analytical
- Use TIF image files instead of paper prints

Digital Photogrammetry

- Same ground control as with analytical
- Use TIF image files instead of paper prints
- Same  as before!

Digital Photogrammetry

Digital Photogrammetry



This is what you see on the CRT monitor.

Digital Photogrammetry

Great Technology but…

- Still need to locate and purchase suitable aerial photos

Digital Photogrammetry

Great Technology but…

- Still need to locate and purchase suitable aerial photos
- Still need to establish ground control for each project

Digital Photogrammetry

Great Technology but…

- Still need to locate and purchase suitable aerial photos
- Still need to establish ground control for each project
- Scanning and image processing is time-consuming

Digital Photogrammetry

Great Technology but…

- Still need to locate and purchase suitable aerial photos
- Still need to establish ground control for each project
- Scanning and image processing is time-consuming
- Full process is still labor intensive, but is a great benefit for geologic mapping

Digital Photogrammetry

Great Technology but…

- Still need to locate and purchase suitable aerial photos
- Still need to establish ground control for each project
- Scanning and image processing is time-consuming
- Full process is still labor intensive, but is a great benefit for geologic mapping
- Any way to streamline the process?

Digital Photogrammetry

Fortunately…yes!

Let's look at the origin of the nation-wide digital orthophotos

National Aerial Imagery Program (NAIP)

- A federal government contract program where every year approx. 1/3 of the nation is covered with new stereo aerial photography; so every state is covered on a 3-year cycle.

National Aerial Imagery Program (NAIP)

- A federal government contract program where every year approx. 1/3 of the nation is covered with new stereo aerial photography; so every state is covered on a 3-year cycle.
- Utah was covered in 2006, 2009, and again in 2011.

National Aerial Imagery Program (NAIP)

- A federal government contract program where every year approx. 1/3 of the nation is covered with new digital stereo aerial photos; so every state is covered on a 3-year cycle.
- Utah was covered in 2006, 2009, and again in 2011.
- This digital stereo aerial imagery is used to produce the 1-meter digital orthos for each state; a separate product.

2009 Utah NAIP Imagery

- Contracted to Surdex Corp., Chesterfield, MO

2009 Utah NAIP Imagery

- Contracted to Surdex Corp., Chesterfield, MO
- Imagery acquired with the Z/I DMC II digital frame aerial camera from Z/I Imaging Corp. Flown June through August, 2009.

2009 Utah NAIP Imagery

- Contracted to Surdex Corp., Chesterfield, MO
- Imagery acquired with the Z/I DMC II digital frame aerial camera from Z/I Imaging Corp. Flown June through August, 2009.
- Image resolution is 12-microns or 2117 ppi.

NAIP Imagery Program

2009 Utah NAIP Imagery

- Contracted to Surdex Corp., Chesterfield, MO
- Imagery acquired with the Z/I DMC II digital frame aerial camera from Z/I Imaging Corp. Flown June through August, 2009.
- Image resolution is 12-microns or 2117 ppi.
- Nominal photo scale is 1:40,000

NAIP Imagery Program

2009 Utah NAIP Imagery

- Contracted to Surdex Corp., Chesterfield, MO
- Imagery acquired with the Z/I DMC II digital frame aerial camera from Z/I Imaging Corp. Flown June through August, 2009.
- Image resolution is 12-microns or 2117 ppi.
- Nominal photo scale is 1:40,000
- Over 13,000 photos to cover the state of Utah

NAIP Imagery Program

2009 Utah NAIP Imagery

- Contracted to Surdex Corp., Chesterfield, MO
- Imagery acquired with the Z/I DMC II digital frame aerial camera from Z/I Imaging Corp. Flown June through August, 2009.
- Image resolution is 12-microns or 2117 ppi.
- Nominal photo scale is 1:40,000
- Over 13,000 photos to cover the state of Utah
- UGS purchased full state-wide stereo coverage for $14,000

Digital Orthophoto

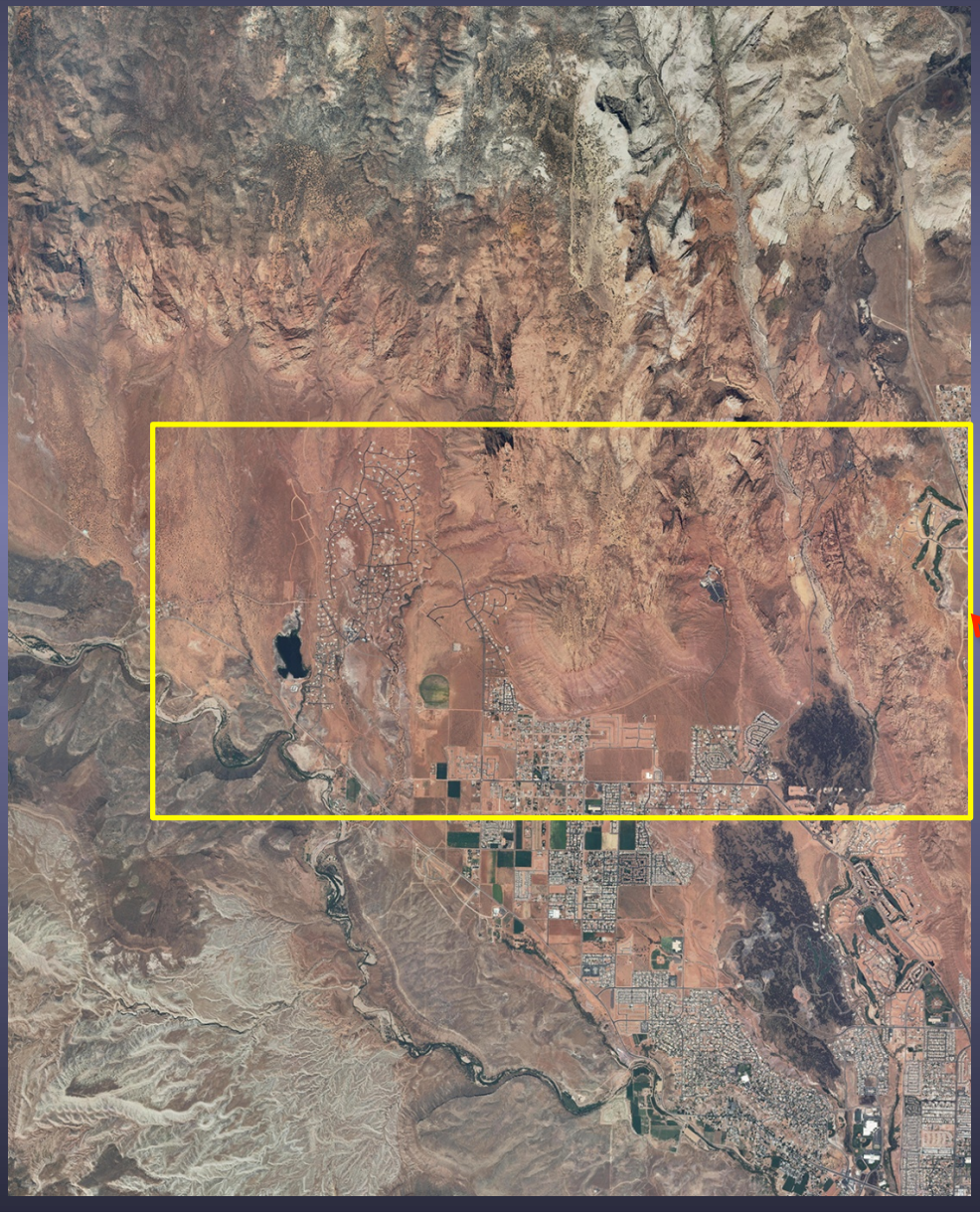
Digital ortho quad from 2009 NAIP imagery

Santa Clara, UT quadrangle

Digital Orthophoto

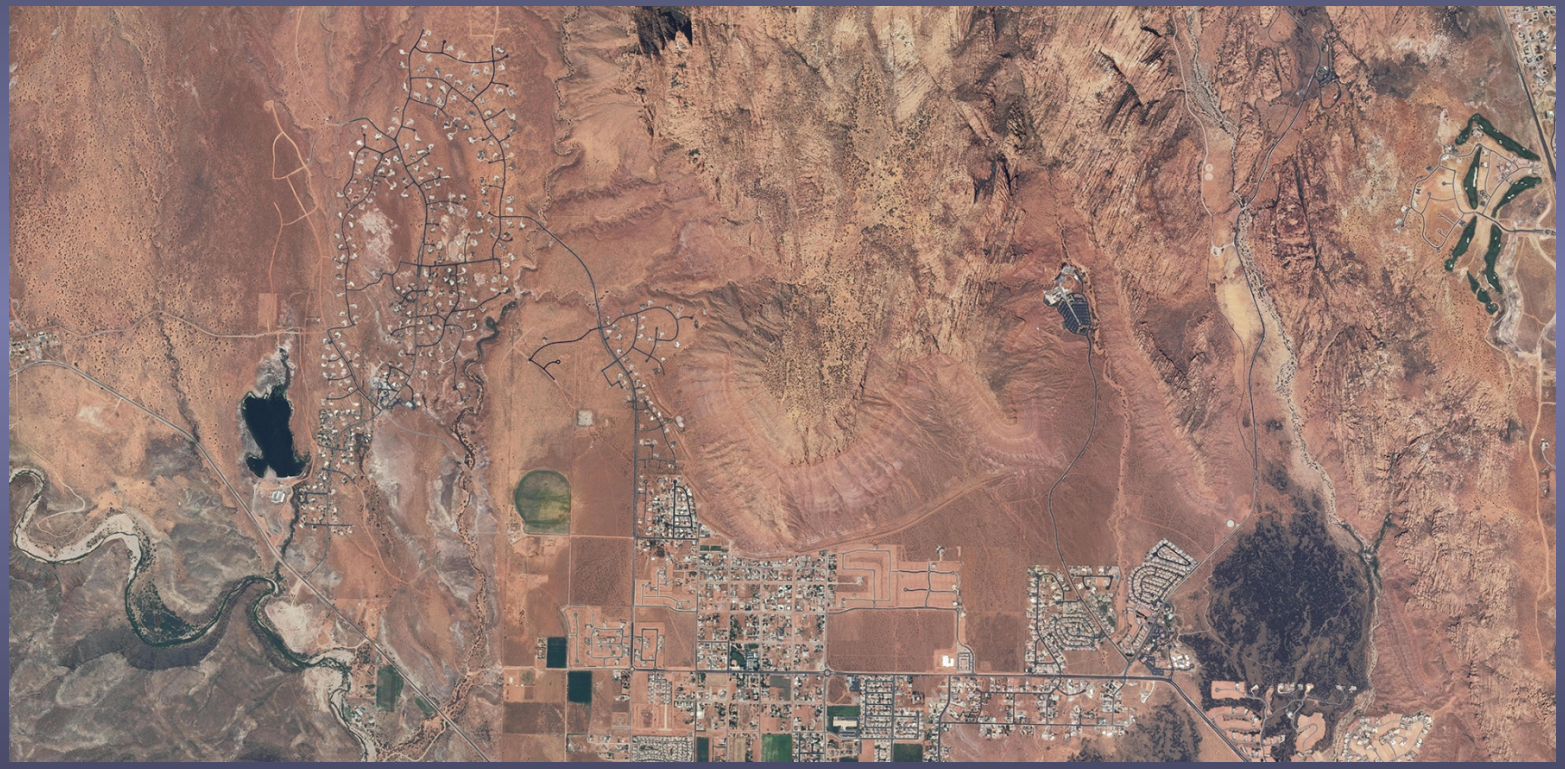
Digital ortho quad from 2009 NAIP imagery

Santa Clara, UT quadrangle



Region of interest

Digital Orthophoto



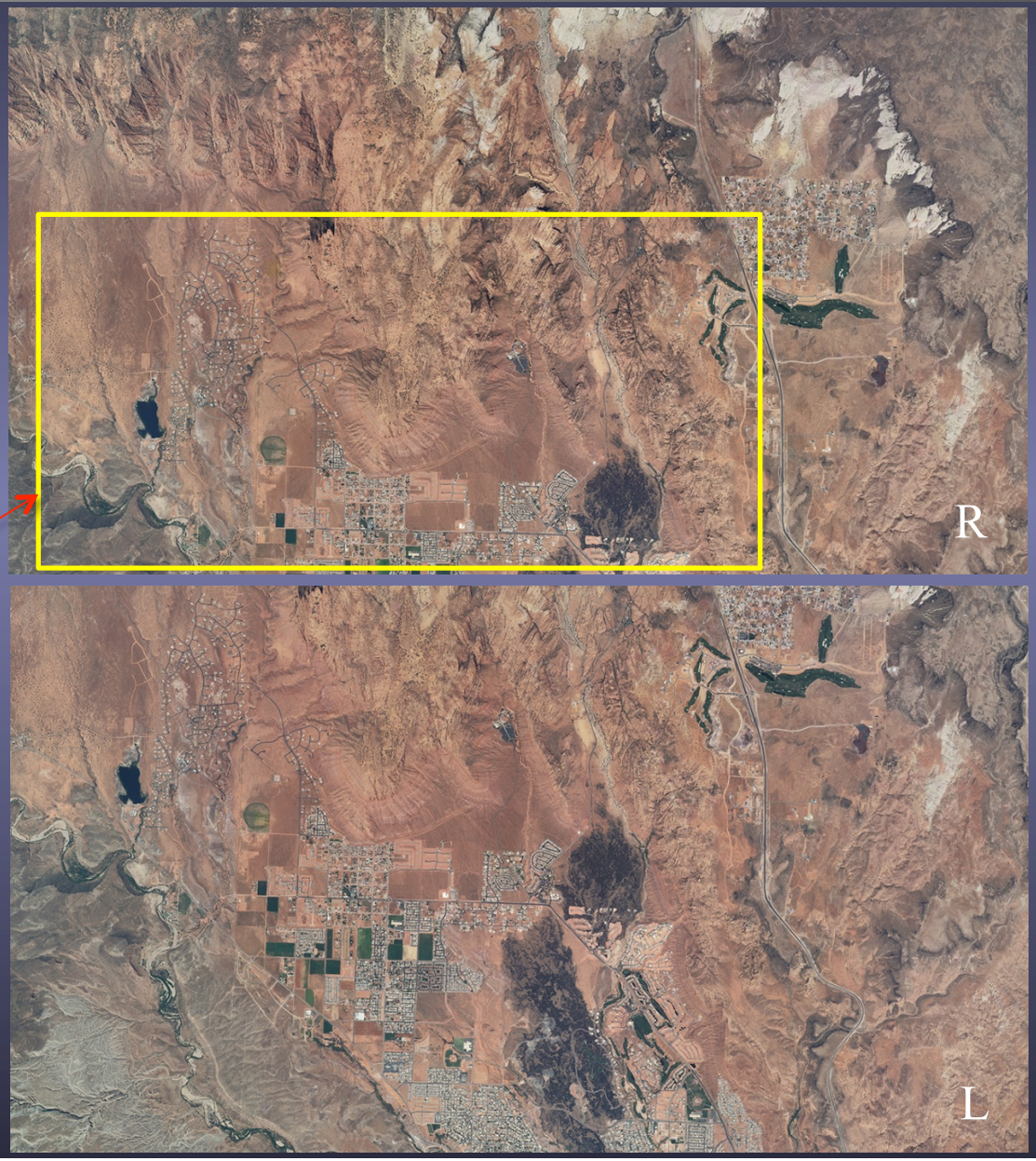
Enlarged region of interest from 2009 digital ortho

Santa Clara, UT quadrangle

Digital Stereo Pair

Stereo pair from digital aerial camera, Surdex Corp., 2009 NAIP imagery.

Same area as digital ortho region of interest

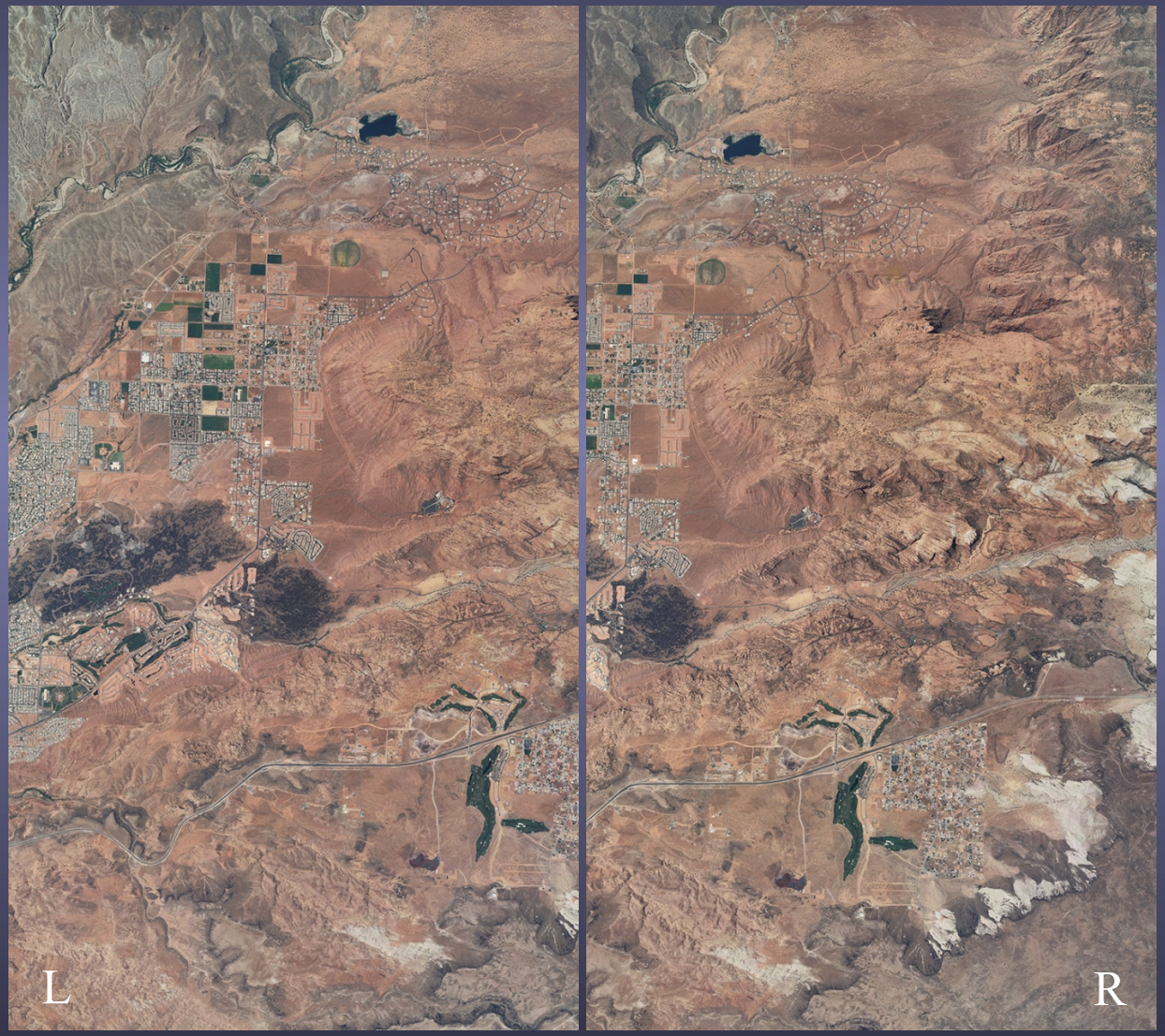


Direction of flight

Digital Stereo Pair

To see in stereo, the images must be viewed from left-to-right, with overlap in the center, so they have been rotated 90°.

Direction of flight

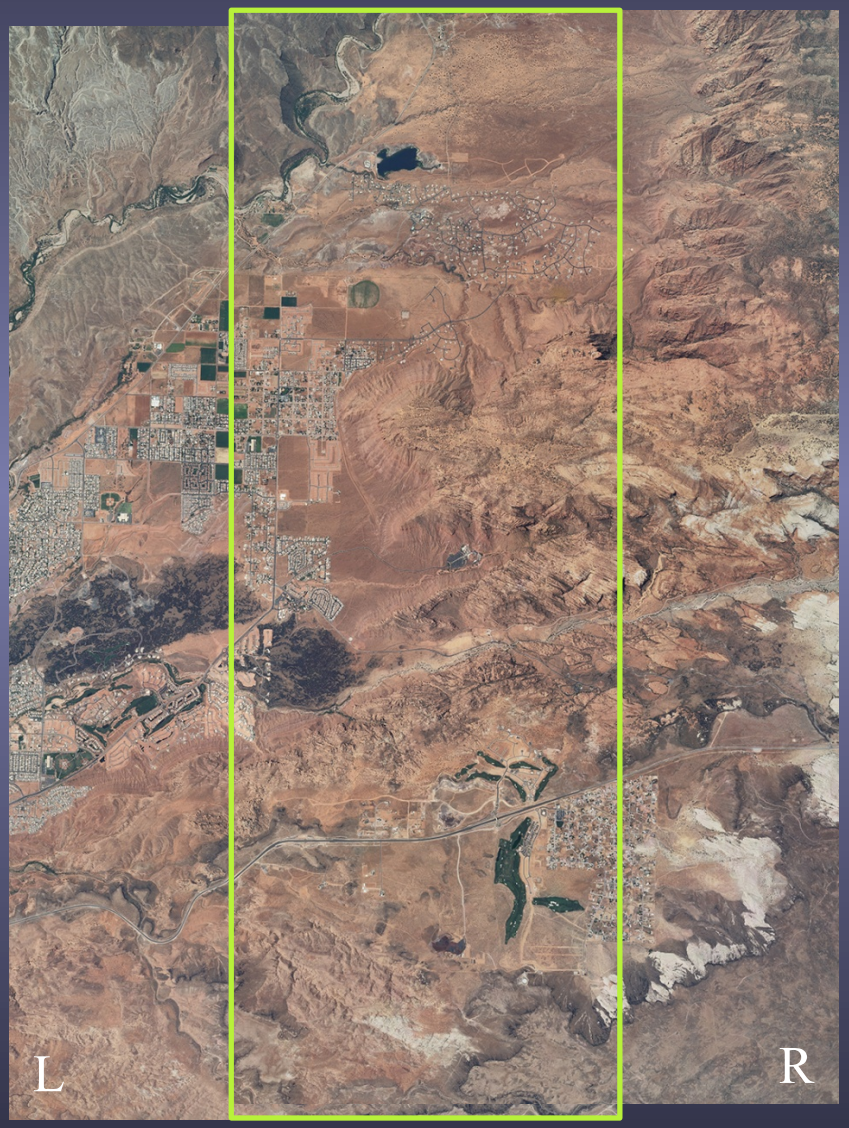


Digital Stereo Pair

Standard overlap for stereo pairs is between 50-60%.

For illustration purposes, the images are overlapped to show that extent.

This area is will be used to create the stereo model.

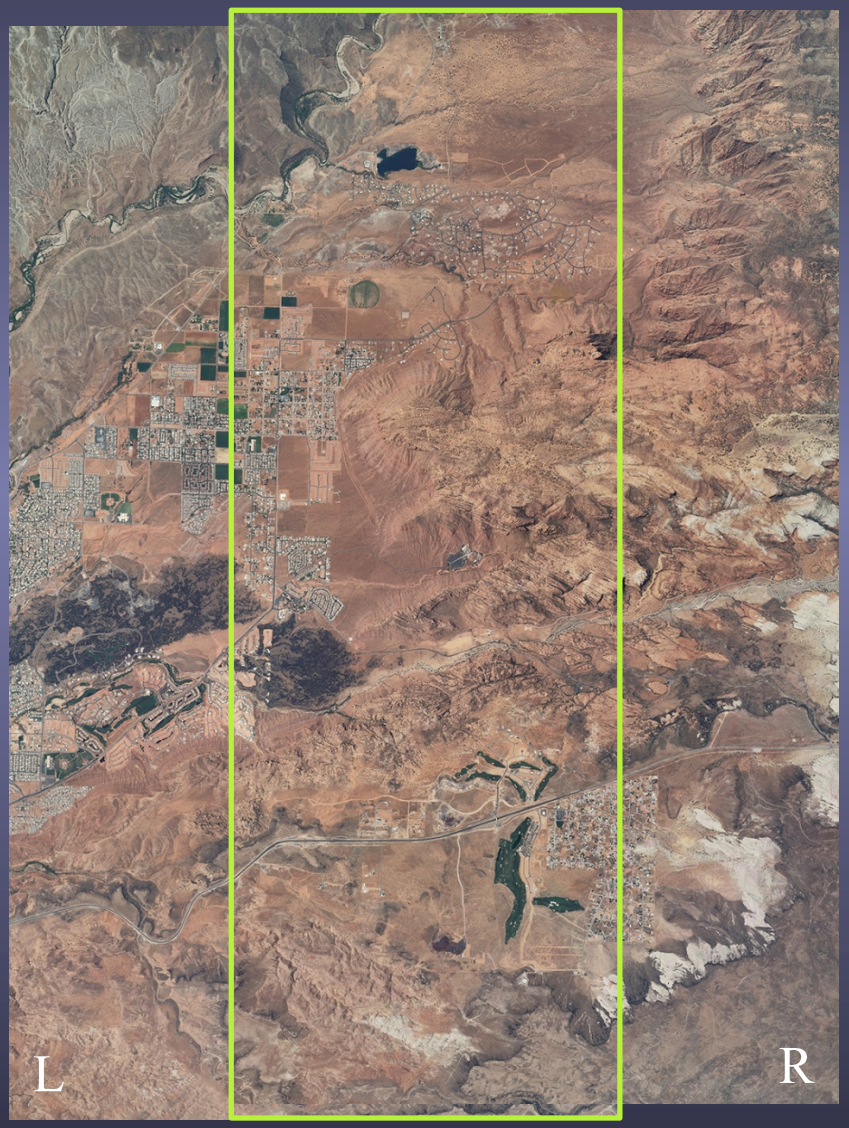


Digital Stereo Pair

Standard overlap for stereo pairs is between 50-60%.

For illustration purposes, the images are overlapped to show that extent.

This area is will be used to create the stereo model.



At this point the stereo pairs are raw, uncontrolled images.

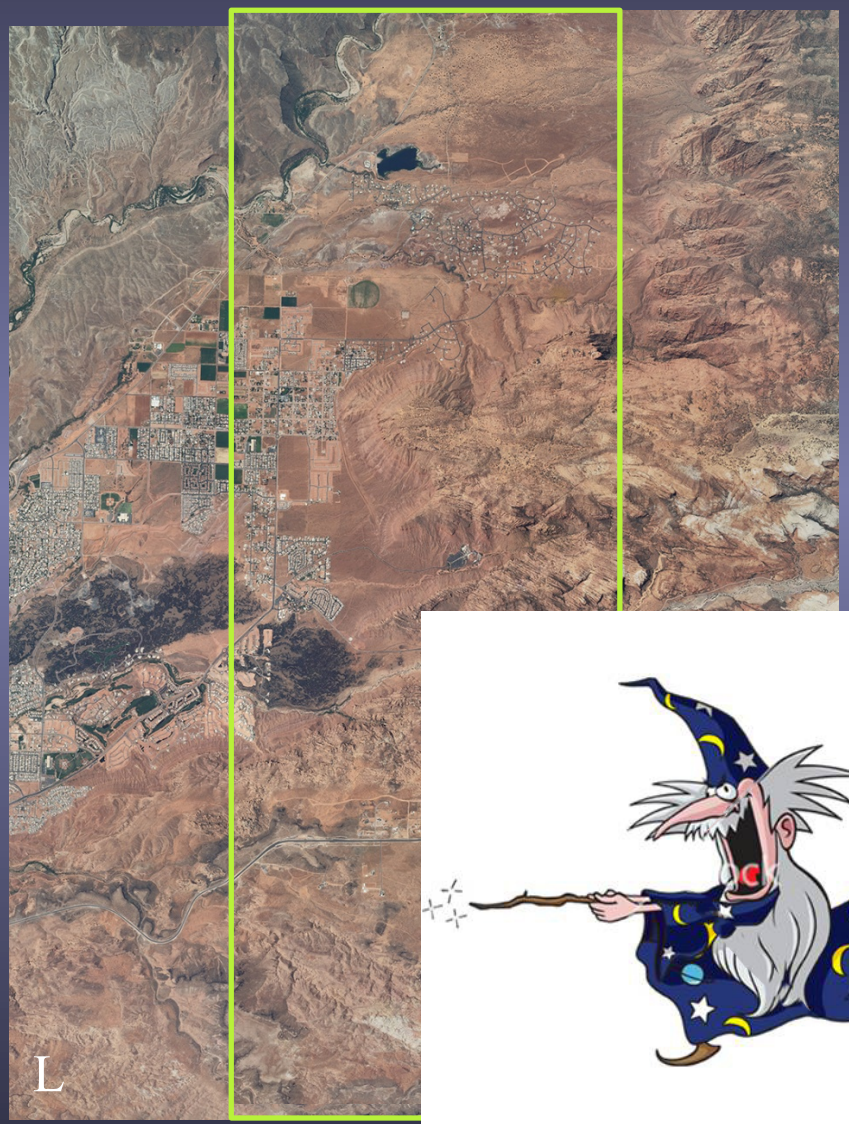
Three orientations are needed to create the controlled stereo models.

Digital Stereo Pair

Standard overlap for stereo pairs is between 50-60%.

For illustration purposes, the images are overlapped to show that extent.

This area is will be used to create the stereo model.

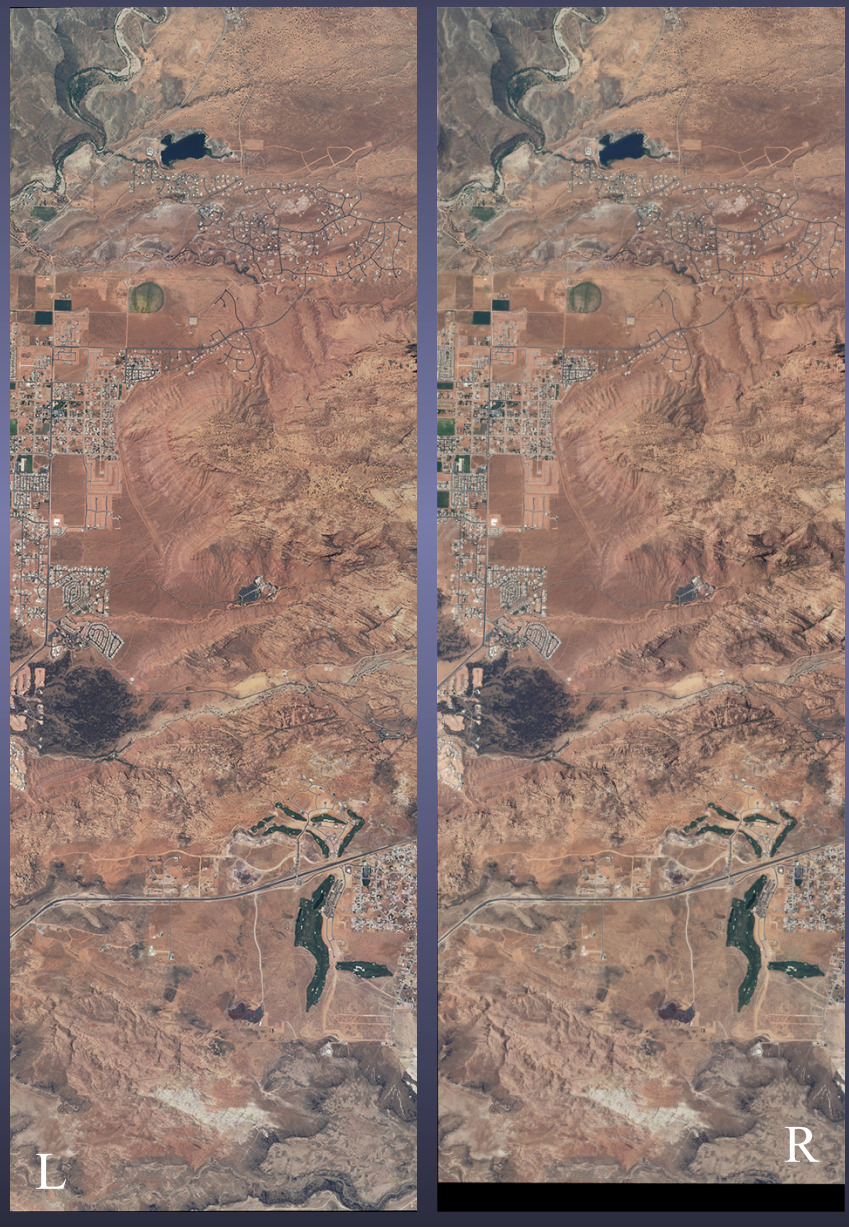


At this point the stereo pairs are raw, uncontrolled images.

Three orientations are needed to create the controlled stereo models.

Digital Stereo Model

After the photogrammetric orientations are done, a new controlled stereo pair is created.



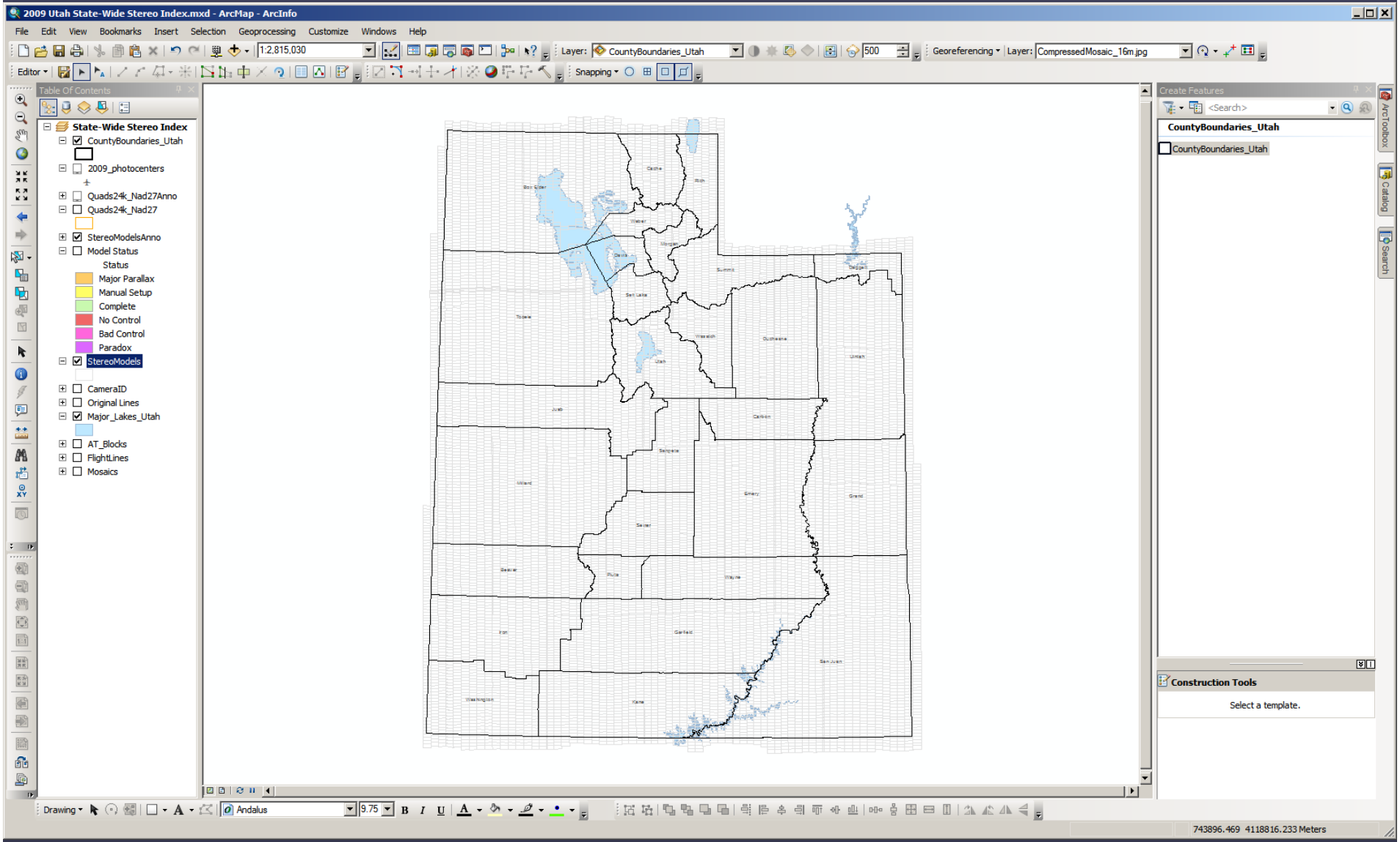
Digital Stereo Model

It doesn't look like much from this screen capture, but this is what it looks like when viewed in stereo using VrTwo, the photogrammetry software we use at UGS.

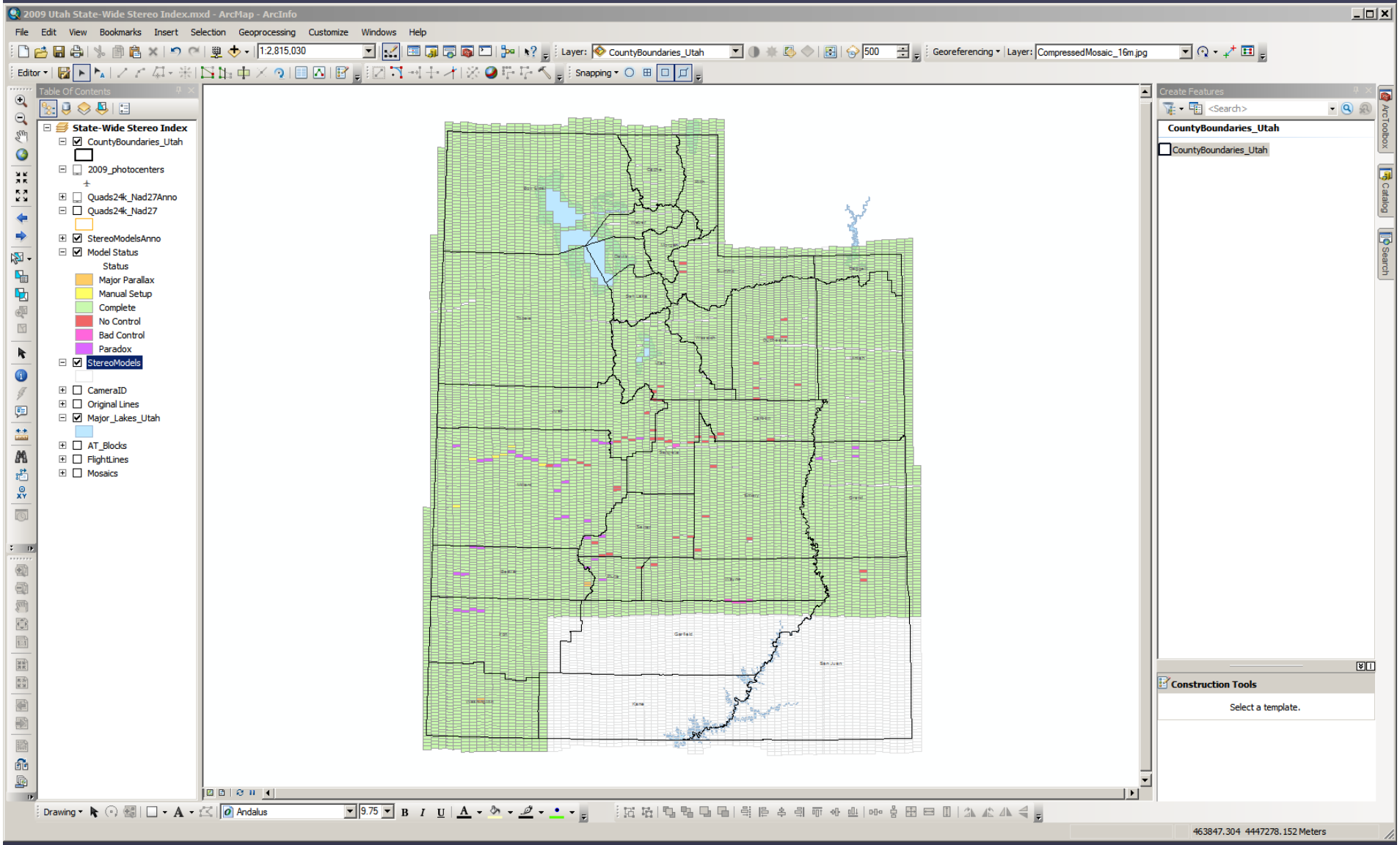
State-Wide Stereo Model Index

With 13,000 stereo models, we need an index!

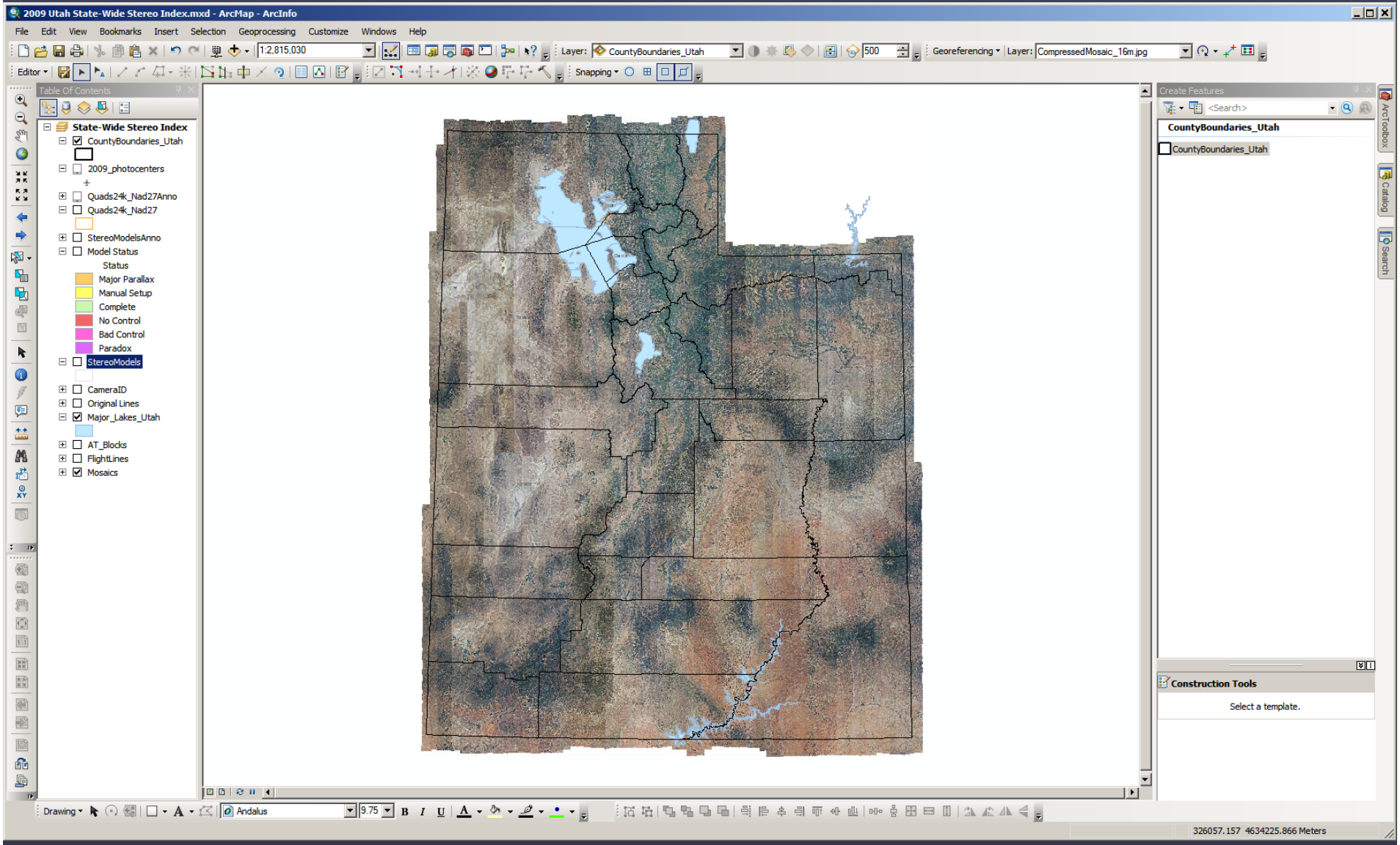
State-Wide Stereo Model Index



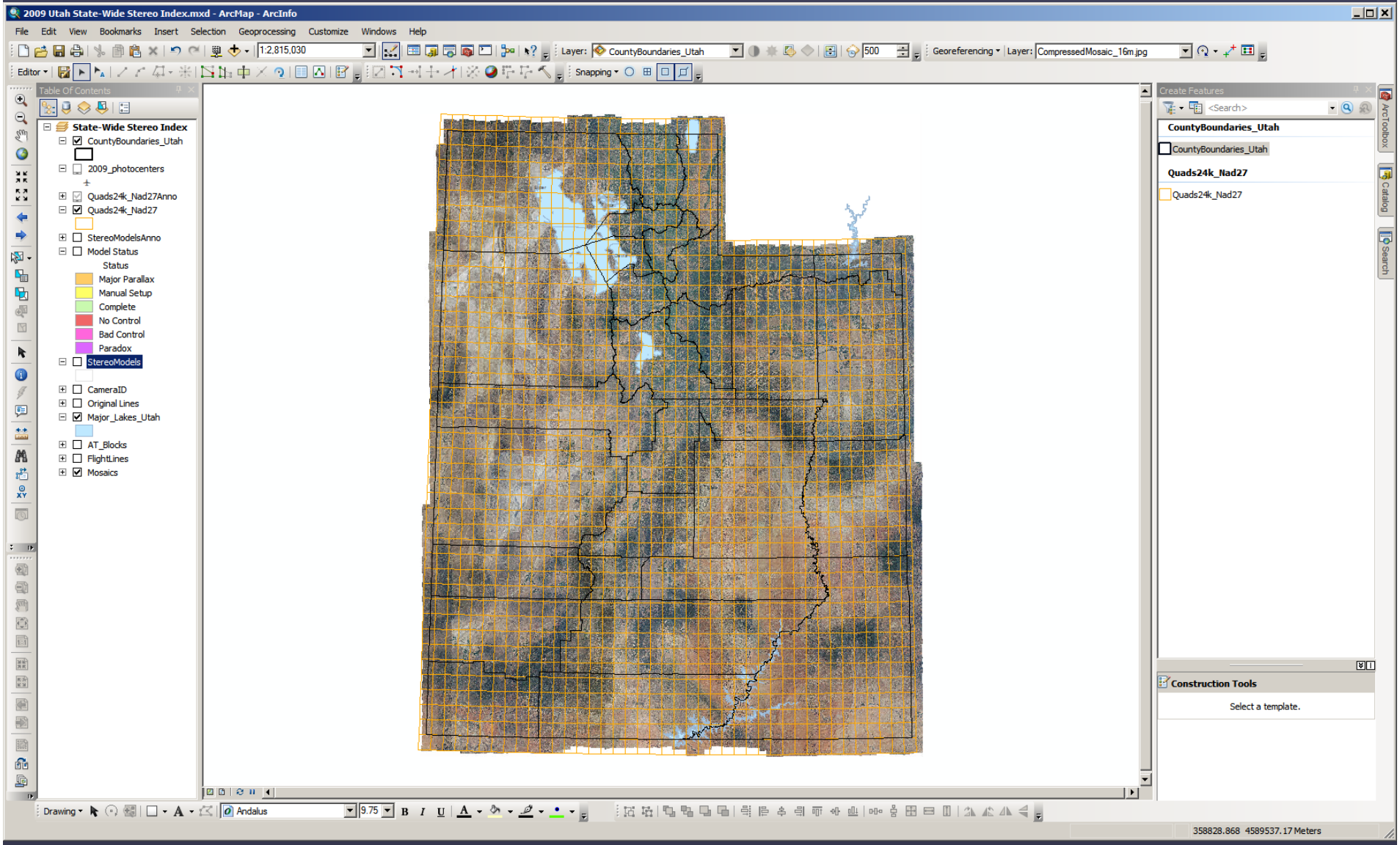
State-Wide Stereo Model Index



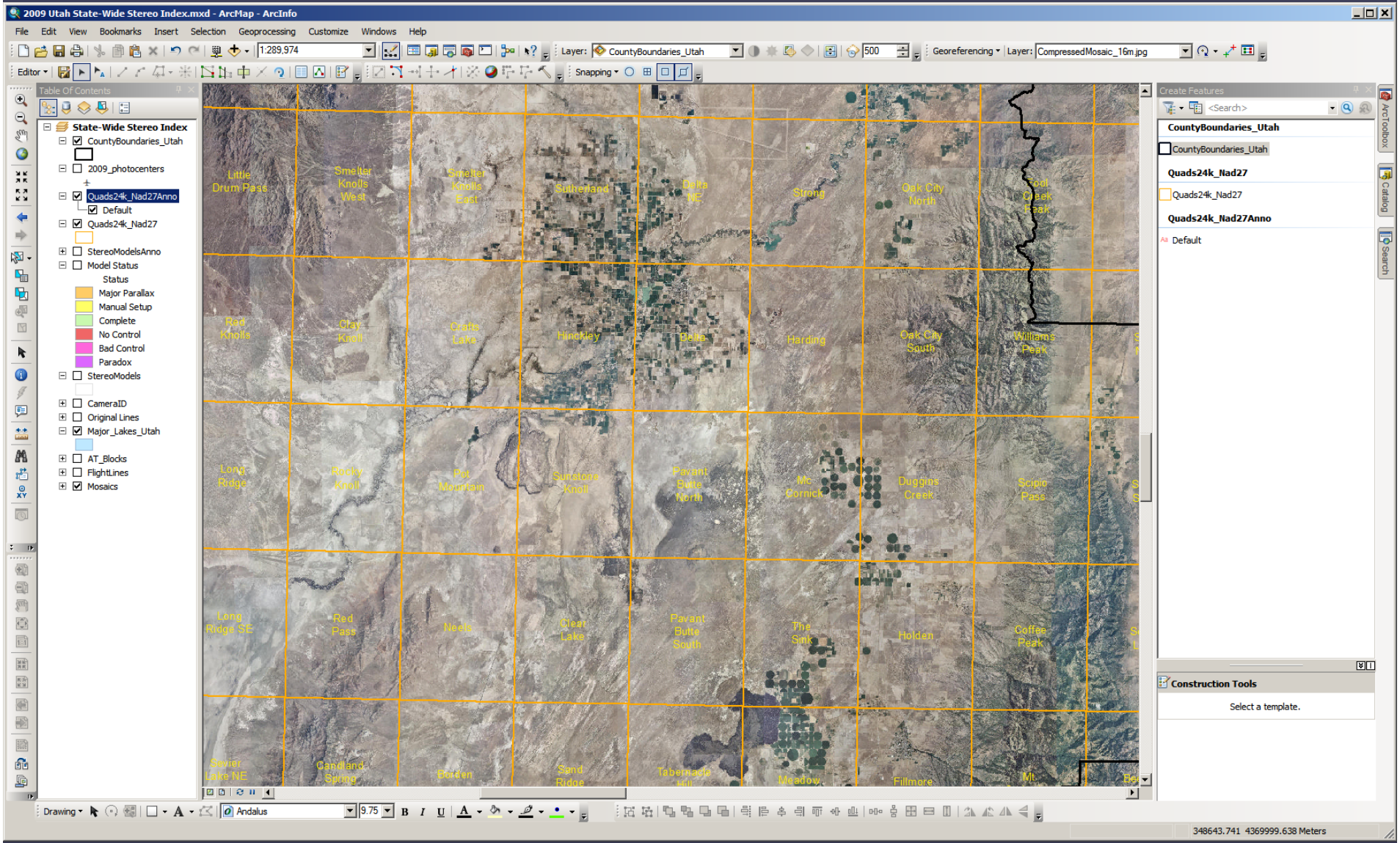
State-Wide Stereo Model Index



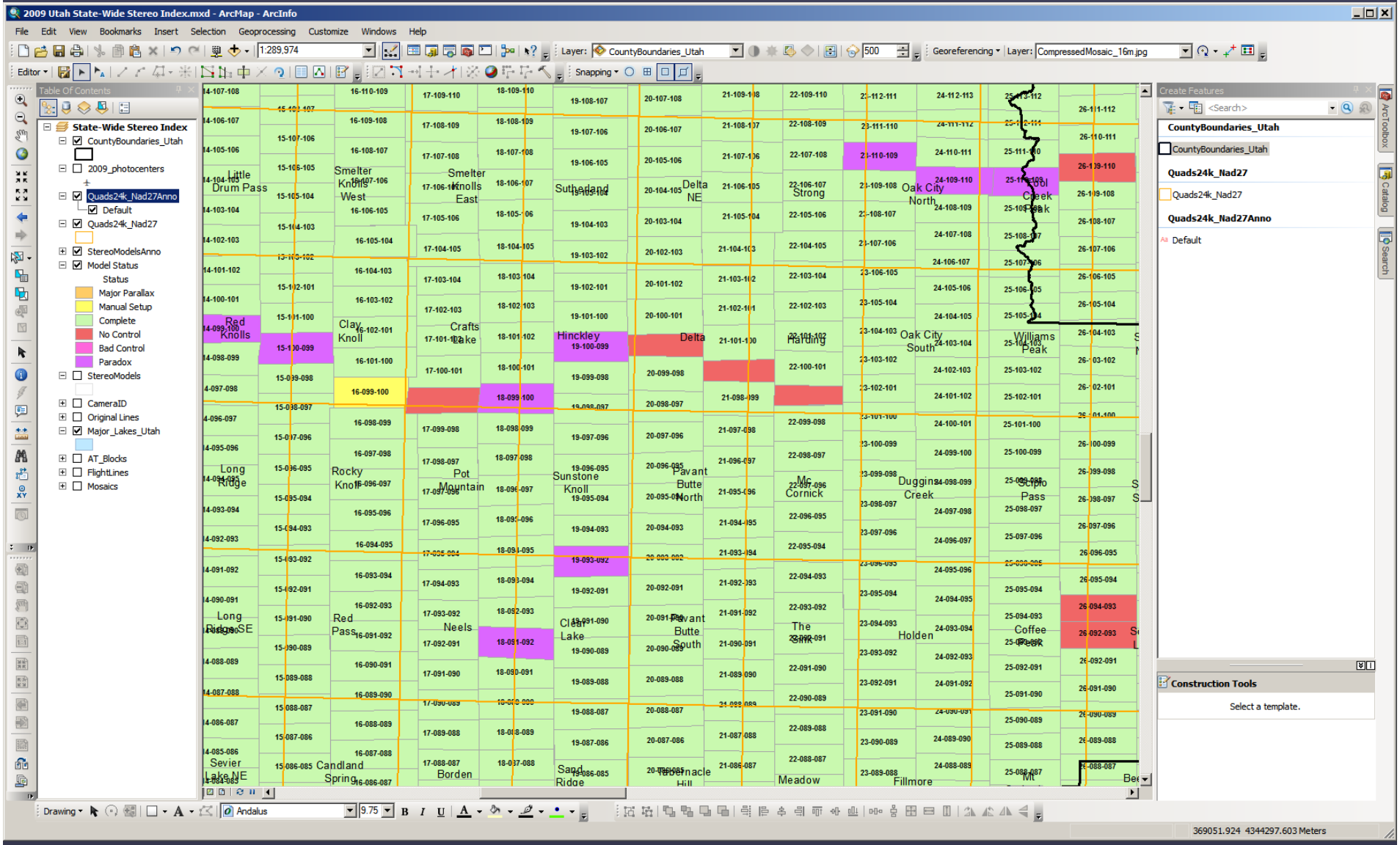
State-Wide Stereo Model Index



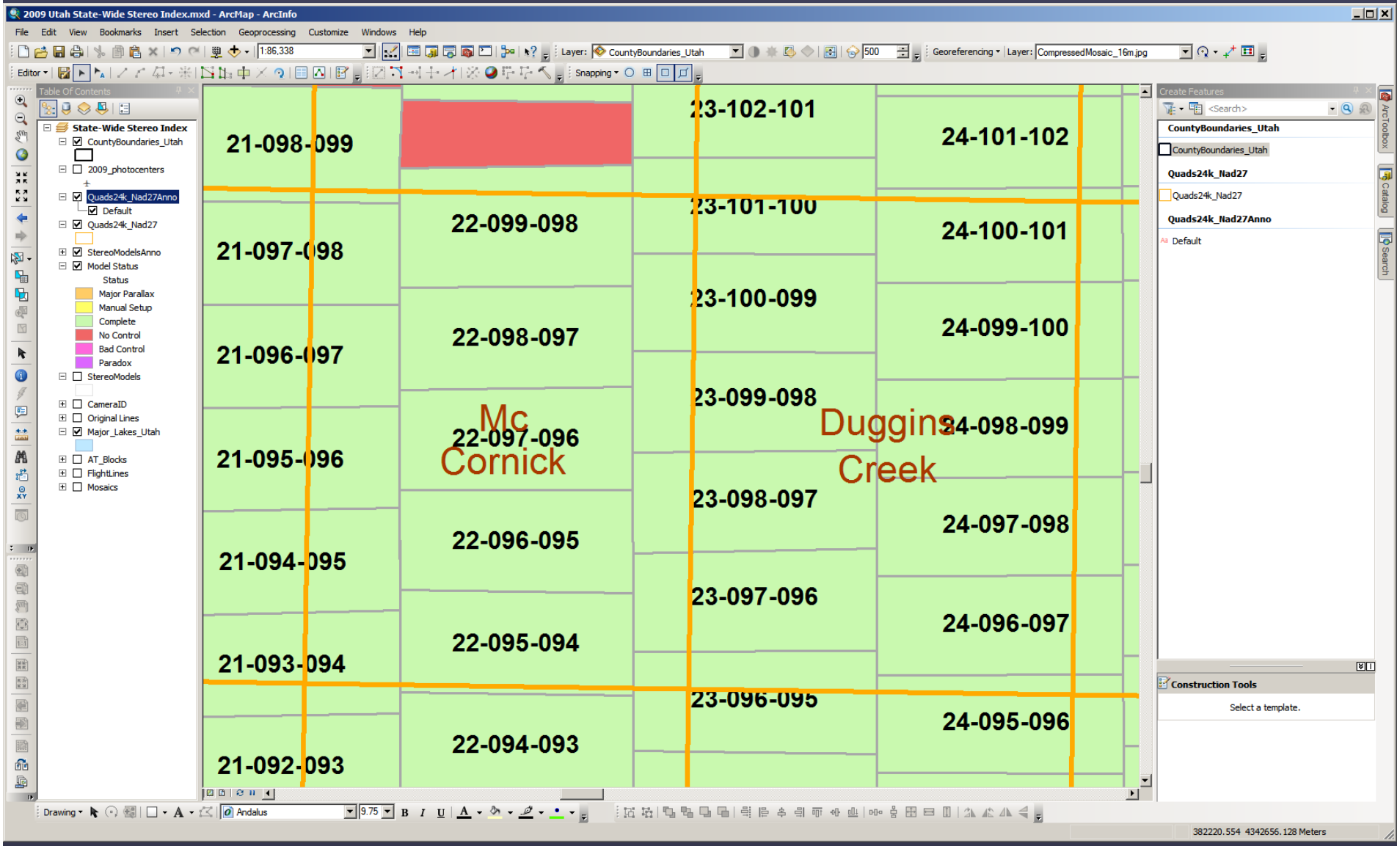
State-Wide Stereo Model Index



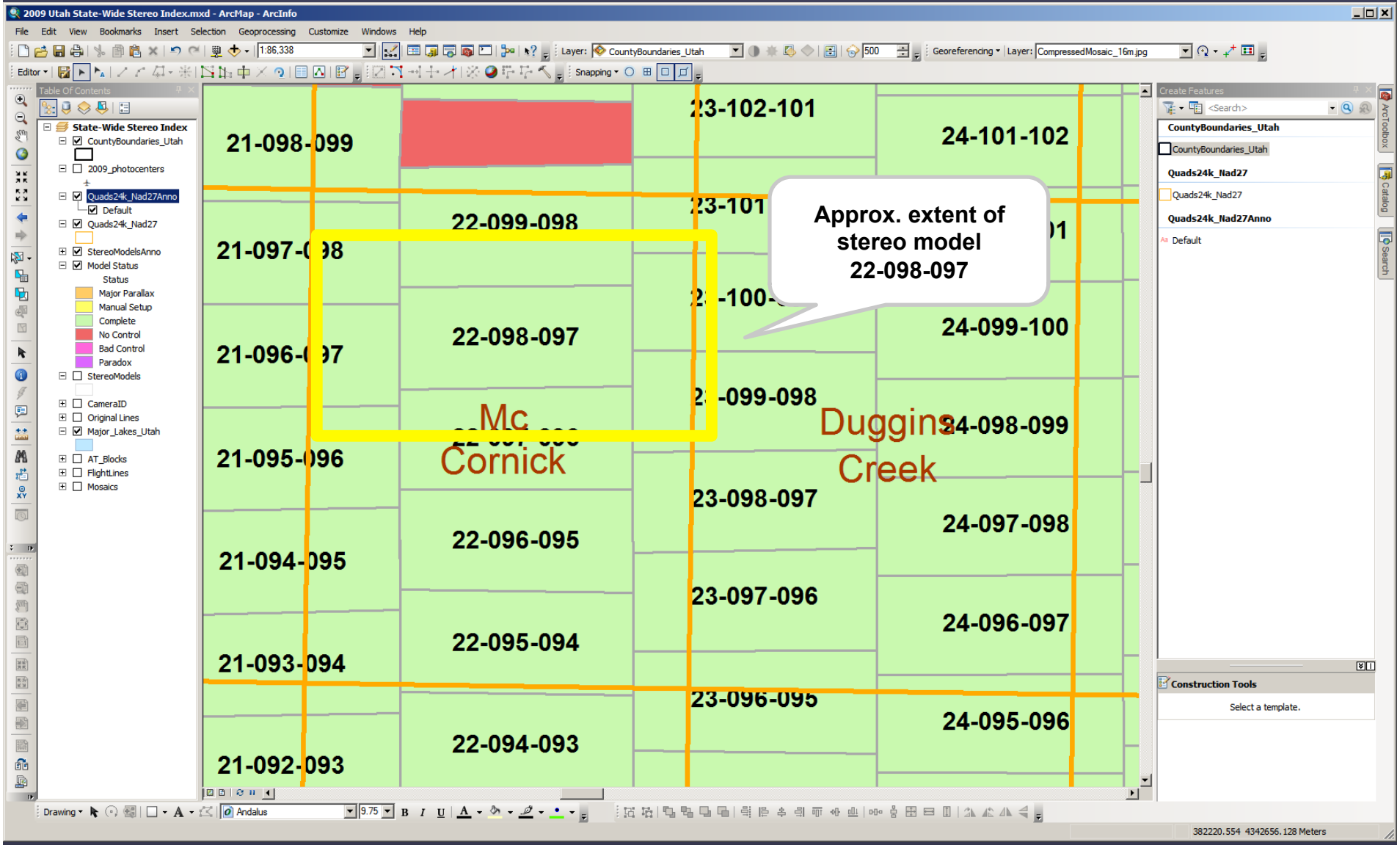
State-Wide Stereo Model Index



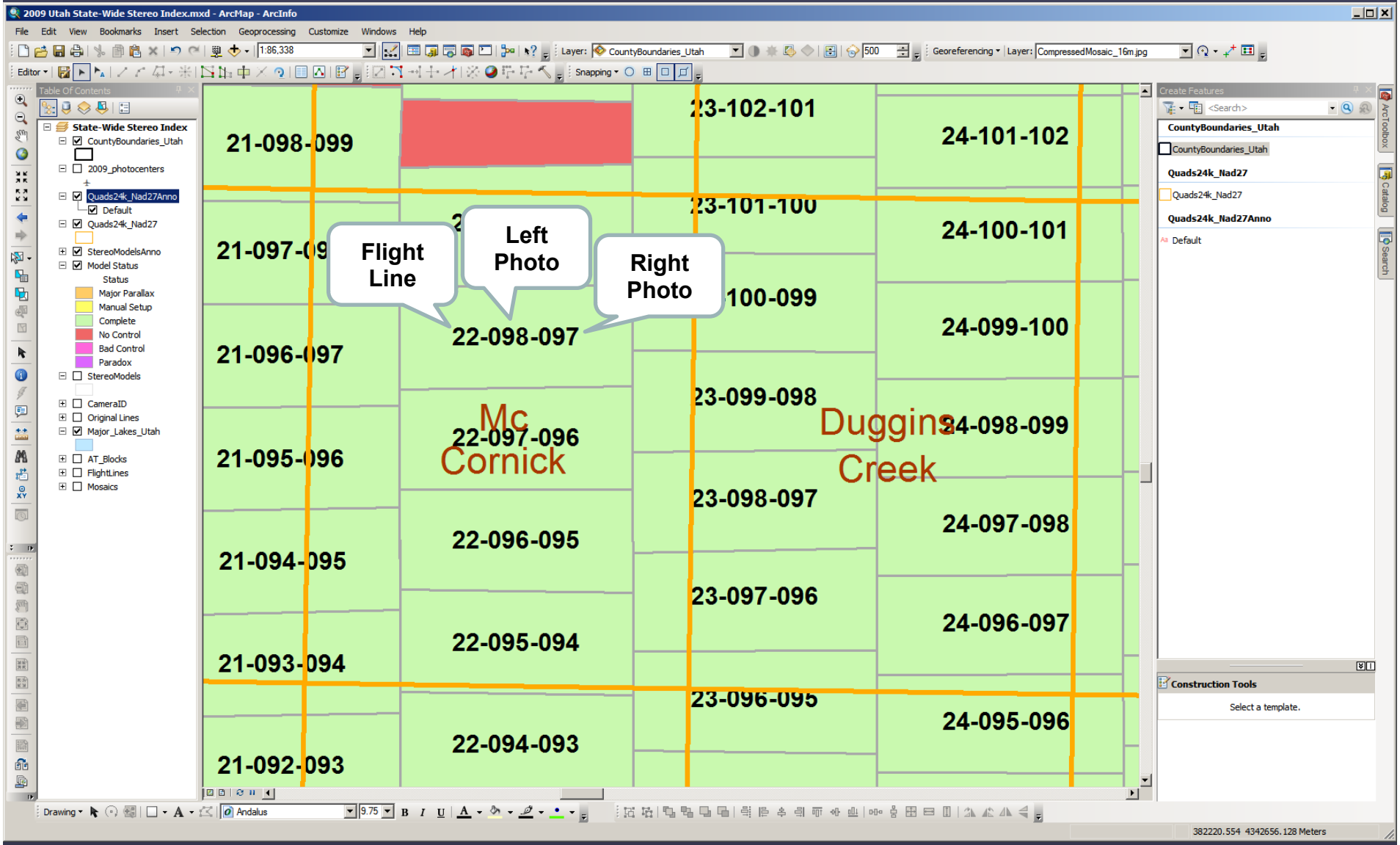
State-Wide Stereo Model Index



State-Wide Stereo Model Index

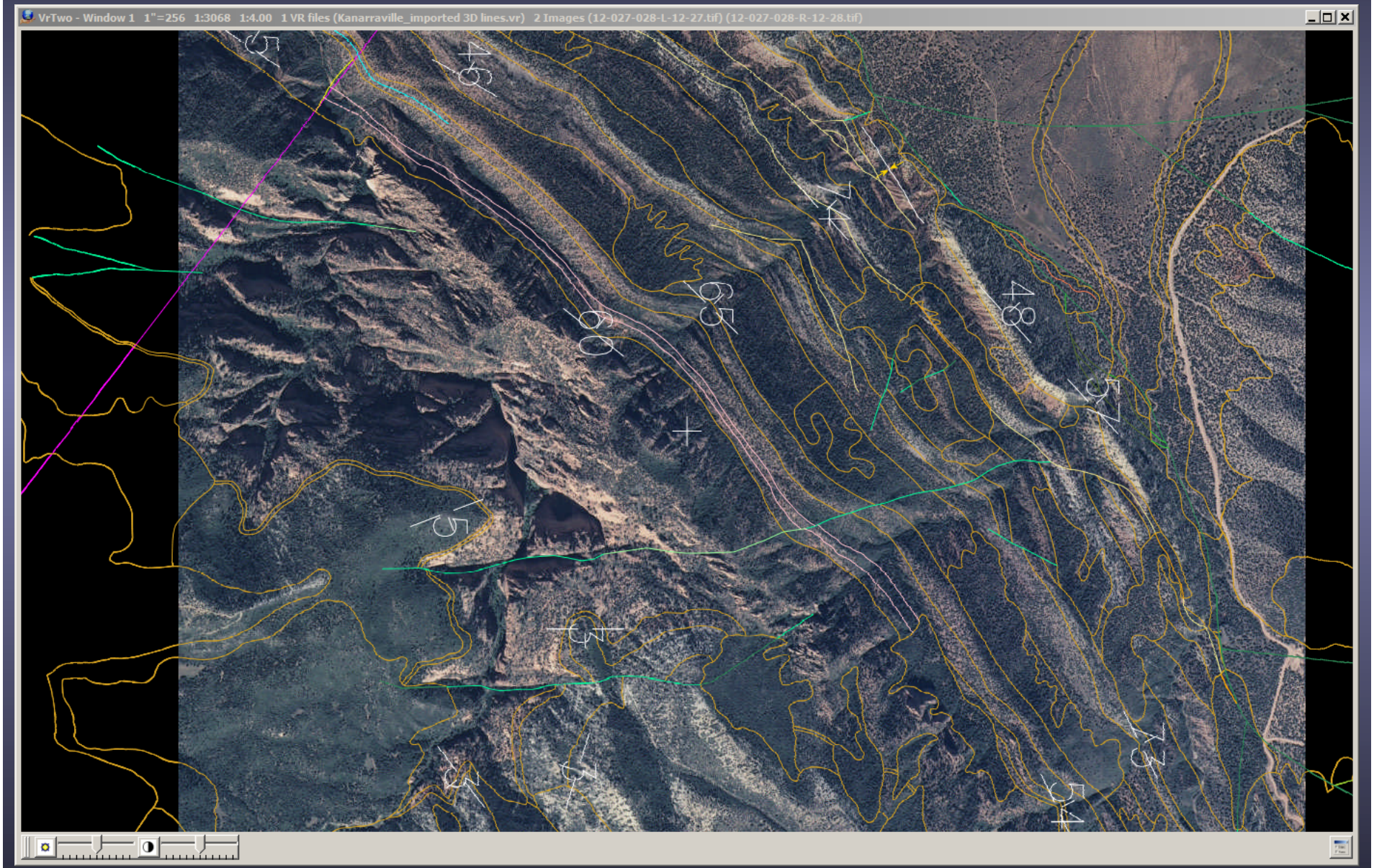


State-Wide Stereo Model Index



State-Wide Stereo Model Coverage

State-Wide Stereo Model Coverage



State-Wide Stereo Model Coverage

You can do photogrammetric 3-point problems!

State-Wide Stereo Models

What's the benefit of all this?

- You can view stereo models from any area of Utah.

State-Wide Stereo Models

What's the benefit of all this?

- You can view stereo models from any area of Utah.
- Tremendous cost savings by not purchasing expensive photo coverage at the Air Photo Field Office.

State-Wide Stereo Models

What's the benefit of all this?

- You can view stereo models from any area of Utah.
- Tremendous cost savings by not purchasing expensive photo coverage at the Air Photo Field Office.
- No more laborious job of establishing ground control.

State-Wide Stereo Models

What's the benefit of all this?

- You can view stereo models from any area of Utah.
- Tremendous cost savings by not purchasing expensive photo coverage at the Air Photo Field Office.
- No more laborious job of establishing ground control.
- The system can benefit anyone who has a need to map on a 3-D surface, in stereo.

State-Wide Stereo Models

What's the benefit of all this?

- You can view stereo models from any area of Utah.
- Tremendous cost savings by not purchasing expensive photo coverage at the Air Photo Field Office.
- No more laborious job of establishing ground control.
- The system can benefit anyone who has a need to map on a 3-D surface, in stereo.
- Approx. 500 custom geologic mapping functions in VrTwo.

State-Wide Stereo Models

You too can be stylin'

Questions?

Kent Brown
Utah Geological Survey
kentbrown@utah.gov
http://geology.utah.gov